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SPRING 1980  
VOL. 2, NO. 2

# Destinies

Edited by JAMES BAEN

THE SCIENCE FICTION MAGAZINE



ALL NEW  
JAMES GUNN  
JOE HALDEMAN  
FREDERIK POHL  
J. E. POURNELLE  
NORMAN SPINRAD  
JOAN VINGE  
MORE!

COVER STORY:  
**BELLEROPHON**  
KEVIN CHRISTENSEN



## AND THE FIRST SHALL BE LAST...

WELCOME to #7, the Spring 1980 Edition of *Destinies*, and another stellar line-up. As promised, the cover story is by Kevin Christensen, and it's something special. Also we have a truly bizarre little specimen by Joe Haldeman and a superb alien-artifact story by Joan Vinge. "Why Must They All Have My Face," by Dean Ing will make you weep for America, so plausibly horrific is the future it unveils for our cities. If it doesn't get nominated, there's no justice.

After you've dried your eyes, try "The City and the Critics," by James Gunn for a different view of Metropolis. Then try Locksley Hall, 2050 AD, by G. Harry Stine; it's as up-beat and plausible as Dean's story is down-beat—and plausible (you pays your nickel, and you takes your choice).

Also we got Norman Spinrad on making life tough for the Russians, Charles Sheffield on Getting About In Space, and *The L-5 Review* with the latest on that proposed abomination, The Lunar Treaty. But perhaps the most important contribution to this issue is Jerry Pournelle's "The Proper Study of Mankind." The Editor explains why in an Afterward to the Appendix.

And now it's time to explain the headline at the top of this page. Surely *primes inter pares* is Robert Anson Heinlein, whose contribution completes this issue. It's the Foreword to his soon-to-be-published (by Ace) *Expanded Universe*, a book which Spider Robinson calls R.A.H.'s most important work to date. And who are we to disagree? Especially since *Destinies #8* will feature massive excerpts!

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The Introduction to what Spider Robinson calls Robert Heinlein's most important book to date. (Coming soon from Ace.)

# Destinies

The Paperback Magazine  
of Science Fiction  
and Speculative Fact  
Spring Edition 1980

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# Destinies

The Paperback Magazine of  
Science Fiction and Speculative Fact

Volume Two, Number Two

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*Continued from page one*

The Summer Edition (known in-house as The Heinlein Issue) will also include an unbiased assessment of Heinlein and his works by well known idolator Spider Robinson, as well as Jerry Pournelle on the latest in custom-made and off-the-rack spacewear, Dean Ing on how to survive a nuclear spasm, plus contributions by Gregory Benford, Larry Niven & Stephen Barnes, Frederik Pohl, Norman Spinrad, and more.

A subscription blank is located on page 31.

See you next issue!

Baen

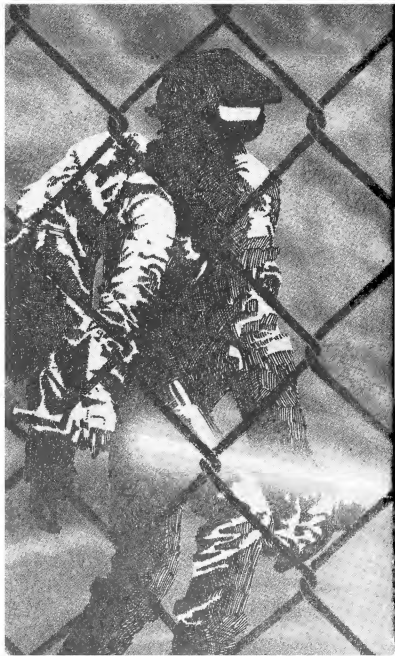
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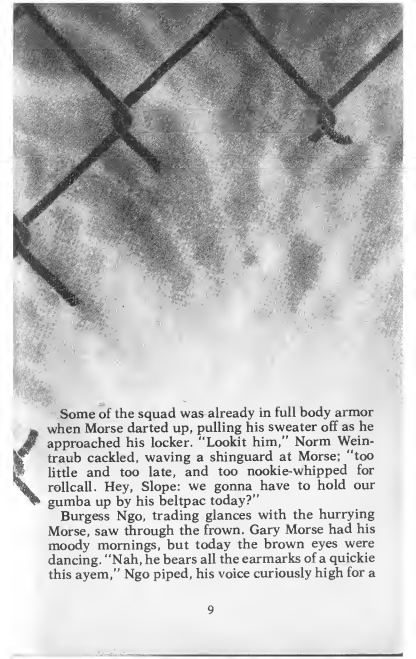
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**WHY  
MUST  
THEY  
ALL HAVE  
MY FACE?**

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DEAN ING



A black and white photograph of a chain-link fence against a cloudy sky. The fence is made of dark, thick metal links, forming a diamond pattern. The sky is filled with soft, white clouds. The lighting is diffused, suggesting an overcast day. The fence runs diagonally across the frame, from the bottom left towards the top right.

Some of the squad was already in full body armor when Morse darted up, pulling his sweater off as he approached his locker. "Lookit him," Norm Weintraub cackled, waving a shinguard at Morse; "too little and too late, and too nookie-whipped for rollcall. Hey, Slope: we gonna have to hold our gumba up by his beltpac today?"

Burgess Ngo, trading glances with the hurrying Morse, saw through the frown. Gary Morse had his moody mornings, but today the brown eyes were dancing. "Nah, he bears all the earmarks of a quickie this ayem," Ngo piped, his voice curiously high for a

man of his bulk. "In another month, Gary'll be a twice-a-week man."

"Never," Morse said, deadpanning as he shucked his civvy trousers. "Fran and I took an extra vow: once a newlywed, always a newlywed."

Morse stepped aside as a fully-dressed gumba trio paced down the aisle, already in lockstep and nearly identical in their massive streetsuit armor. But you could tell by the little things, thought Morse, even from behind if they were on your squad. Sadler carried the mob-control staff with the dent, Torre rolled like a sailor as he walked, and the great height of McEachern was unmistakable. Anyway, if you made one of a trio, you knew who the others had to be.

Of course, once you had your helmet on you could read the infrared-sensitive ID on each helmet. That way you knew which name to call on your streetsuit intercom, in case you had to call a fast warning. Or call for help; sometimes that happened too. In a pitched battle on the street you had to know every other cop at a glance, but it could be toughshitsville if you were identified by some scumbag. Scumbags, mob leaders, had been known to wear IR-sensitive cheaters. That was why possession of such equipment by a private citizen was a felony.

Weintraub and Ngo stood waiting, trading insults impartially as Morse adjusted his streetsuit conditioner. Too cold in summer, too hot in winter, the damned thing was like a bad cop; always over-reacting. Morse had the knack of monitoring his thoughts, caught himself oversimplifying, smiled. It wasn't as simple as good cop/bad cop, either/or, scumbag/lawful citizen. On the other hand you had Sadler, a downright bad case who seemed to be on the force for the single purpose of kicking ass. Offsetting Sadler—validating him, in a way—was Ngo. Burgess Ngo of the ready smile, the easy response to slope jokes, the solid belief in the country that had adopted

his father a generation back. Ngo, the true believer in the system. Gary Morse envied his gumba that almost religious certainty that a cop, particularly a strike force cop, was part of the solution, not part of the problems.

Problem: Life support for City Center, where the council and the tax and licensing people and urban service engineers and their clerks and secretaries huddled behind thick earth-filled walls, insulated from street people. Too much life. Too little support.

Problem: Protection for convoys that kept City Center supplied. With luck, the central nervous system of the self-besieged city might continue desperate efforts to save something, anything, of its gangrenous body. Last month a bottleneck had emerged in printout software. A flying wedge of students had surprised a convoy, had 'liberated' palletloads of paper for outlying schools. This month it was food.

Problem: Housing. City Center could not provide living quarters for its own strike force. If a cop's seniority was low, he couldn't live in a safe zone. He had to make do, somehow, on the outside where he was just as vulnerable to theft and water contamination and shortages as the next citizen. More vulnerable, really, if some scumbag figured out which lucky workers were disappearing into conduits toward checkpoints near City Center, as Morse did.

Problem: Fran.

Cancel that. For Gary Morse, Fran was the nexus of calm in a city gone spastic with its agony. Before the government imposed a city quarantine, very few people were worried enough, and wealthy enough, to get out. Choice terms were reserved for those who did: *bugout*, *candyass*, *noballs*. The social pressure generated by those terms was simply incalculable. A few optimists were still trickling into cities on the day their quarantines were announced.

Even after he found his parents trashed in the wreckage of their home, Gary Morse had never considered a bugout. He could have joined the army, probably to wind up with a night-scoped carbine outside a quarantine area—Newark or San Antonio or Detroit, for example—where escapees got hard labor if they weren't shot first. Or he could have joined a mob; soldiering in the gutter trenches of his own city. Or he could take police exams; fight the good fight.

Morse was not a tall man. Not tall enough for the job, one academy instructor had warned. But the tenacity was there, and the shoulders were wide and thick, sloping into a heavily corded neck. If Gary Morse stood half a head shorter than his gumbas, the muscular upper torso could still inspire respect. Fran always claimed she'd singled him out because she was a neck-and-shoulders girl. Well then, solution: Fran.

Annafrances Kohler, tousled locks gleaming velvety umber on a high forehead, blue eyes melancholy as she had waited in a job applicant line two years before. Morse had tried to ignore the lithe girl, obviously fresh from the country in her clean frock (too short) and her farmgirl legs (too strong). But he couldn't ignore the pimp who was jiving her. Neither could she; when the jiver touched her elbow it became a weapon and the man needed Morse's help to find the exit. Morse returned to pay his respects, and one thing led to another, and—.

Fran Kohler, defusing his anger when Gary saw the condition of her hands, the first day when she returned from work in a suburban berry thicket. "No one forced me to do it," she had whispered into the hollow beneath his jaw.

He had kissed the ravaged fingers, juice-dyed and bitter-slick under synthoderm that stopped the

bleeding. Voice tight, hoarse: "No one forces you to eat, either. You've got to go home, Fran. Now, while you still can."

She hadn't quite lost her naivete. "I'll always be welcome back home," she'd said, nipping at his ear.

He'd turned, regarding her with one eye, so near she was a fragrant blur of honey-tints. "If you can get there. Rumor in the Academy, Fran: they'll be forming street control squads soon."

"That means a full-time position for you," she'd said, pleased.

"It means they know the city's going under quarantine soon."

Her mouth an *Oh*, silent, gravely waiting.

"I give us a month, six weeks at most," he'd said.

"Then you'll just have to come away with me."

"You know I can't. I'm signed up, and they're already checking ID's at the terminals. God *dammit*, honey, it'll be hand-to-mouth for you here in a month. No contacts, no family,—"

"No husband. Well," her grin was enterprising, "I'll just have to find one."

"I couldn't do that to you."

And she had transmuted the grin into a whore's leer, her special joke for him, tonguetip provocative between her teeth. And after she'd found an apartment—

Fran Morse, *nee* Kohler, self-assured and regal in their shabby digs a week after the wedding. Ngo and Weintraub had failed to hide their amazement when they arrived and quickly gave up trying.

From Norm Weintraub, indicating the whole room with arms outflung: "Wine and canapes and a lady from the Lido: magic, by God!"

"Dandelion wine and zucchini pizza," she'd said, pleased but coloring slightly under the Weintraub appraisal.

Burgess Ngo: "You two just got in under the wire,



y'know. Gary was the last gumba on the force to get permission to marry."

They had drunk to that, then to early revocation of the new quarantine, and then to advancement that could lift Morse from the ranks. And then to other brave dreams.

Late that evening, all of them fuzz-brained from dandelion wine, Ngo in all innocence had committed an unpardonable sin. He'd broached the really insoluble problem with, "Here's to schizophee—uh, schizophreniacs," surprised that he could still pronounce it.

Fran didn't understand; Gary winced.

Glancing around him at the suddenly morose Weintraub and Morse: "You know, Gary on the strike force and Fran hustling the necessities—"

"Let it lie, Burgess," from Weintraub.

"There's a key word, if I can say it," Morse had begun. "*An-on-ymity*; and thanks a bunch for bringing it up, pal." By now, Ngo understood his faux pas; a cop didn't say 'pal' if he was in a good mood. It had been the gentlest of warnings.

"I know what you mean," from Fran in slow cadence, each syllable deliberate and clear and earnest. "We've worked it all out, Burgess. At home, Gary is a man without a job. On duty, he is a man without a wife. Me, too—I mean, you know. But I won't take crazy chances. And Gary won't ask where I get the sirloins."

The very idea of sirloin had been too ludicrous, had produced helpless guffaws from them all. Finally, from Ngo who was still trying for a comic effect: "Okay, you've worked it all out." Shrug. "And it still spells schizo."

That was when Norm Weintraub yelled at him. It was two interminable minutes before Fran discovered how to quell the two of them. She merely went about building another pizza, claiming that there

was plenty more, her lie opaque beneath a dandelion-yellow glow.

And long after the others had gone, sharing the pallet and their bodies in eager communion, they had heard a single despairing cry from somewhere outside. Someone was hustling his necessities.

The sleep that Fran found so easily was denied Gary Morse. He fought back to wakefulness, recoiling from a nightmare image that would not wait, that fled as he pursued it. It seemed that he gazed down on some great stone wheel that rolled endlessly in a circular groove. Filling the groove, in the path of the rust-stained wheel, lay countless granules too small to be clearly discerned. Morse had never seen a millstone, but the imagery had plagued his sleep before.

Eventually he came to a conclusion. *The mills of God*, he remembered. Had it been Whitman? Longfellow? Thus deflected, he had fallen asleep.

To make a liar of Weintraub, Morse made it to rollcall—barely. Lieutenant Rawlins would not keep them long with the briefing, he said; and then kept them too long. The gist of it was, Squads One and Three would provide security for the convoy coming eastward into City Center. Squad Two, he said, was slated for special duty.

Weintraub vented a moaning grunt without parting his lips and Morse, standing just ahead of him, agreed with the faintest of gestures. Special duty meant the shitty end of the stick, a breakneck race in armored vehicles to some crucial strongpoint beyond City Center, timed to coincide with small supply convoys. Today it was the main power station.

When Rawlins dismissed them, Ngo moved to Weintraub's side as they unhinged their helmets. "You have a microfiche map of the power station, gumba? I don't know the area."

"Morse won't need his," Weintraub said. "He knows that part of town backwards."

Morse nodded, fumbling for a microfiche card in his beltpac. "Big gray building down the hill from my place, about two clicks," he said. "Tall smokestack; looks like a fort." He handed over the card, watched Ngo don his helmet to study the brow-level display inside.

The voice even thinner through the visor: "Got it. Yeah." Reflective: "When I was a kid I used to wonder why city buildings looked like fortifications."

"Be glad they do," from Weintraub.

"Civil engineers were thinking 'way ahead," Morse sighed. In unspoken agreement they strode toward the staging area. You didn't want to be the last trio on a strike force van; the lumbering vehicles hadn't been designed to take the weight of the armor. You could lose your breakfast sitting near the tailgate, the way the van swayed on overloaded springs.

The drivers careened out from the Center with self-conscious brio, each taking a different route, each making tires squall at the limit of adhesion around corners, swerving past old road blocks. Some of the roadblocks had been their own. Some, identifiable by the ragtag ends of furniture dragged from office buildings, had been the work of mobbers. A few scumbags had the knack of fitting hardwood furniture into barricades of appalling toughness.

"Uh-oh," Ngo muttered, nudging Morse. "Sadler looks a little barf-baggish." Sadler, near the tailgate, was paying the price. You weren't supposed to stand up or hang over the chest-high tailgate, but you weren't supposed to barf inside the vehicle either.

Weintraub, in muttered fraudulence: "Couldn't happen to a nicer guy."

Without a word, Morse worked his way past the others, touched Sadler on the shoulder, jerked a thumb back toward his vacated seat. After a moment

Sadler nodded, his face blank, and left Morse to lean on the tailgate alone. Now and again, Morse saw the jagged gray fingernail of the power station smoke-stack pointing skyward over a gutted building in the foreground. He squinted back at the occasional bright sparkle of glass shards in the street, enjoying the sensation, disdaining the polarized visor. Once he saw a boy standing immobile on a corner, watching the truck in its headlong progress. Morse waved. The boy did not wave back.

Morse recognized the market where he sometimes shopped, on days off, and when the plywood facing was removed to imply that food was available. Today the plywood was up in place and there were very few people in sight. Not nearly enough people in sight, he thought. That was something Morse could allow himself to think about, though perilously near things he could not afford to think about.

The ready signal flashed. Morse was staring across the city and did not see the signal. He knew it had flashed when he sensed the change in the others. Psych-up time: time for rousing the inner man, for quickening the adrenal flow before battle was joined. Morse wondered if it was pan-cultural, if it had really worked for Sioux, Zulu, North Koreans. Assuredly it worked for his gumbas. He heard Sadler, whose curses grew stronger by the moment; felt a flutter in his own guts; smiled because he knew he could not lose his own breakfast. There had been no breakfast to lose.

The trio swung from their van two blocks from the power station, the vehicle lurching forward again to disgorge others fifty meters beyond. Ngo stumbled, cursed, hurried to take his position. He was leaning on his mob-control staff, Morse saw.

Weintraub, by intercom: "Geez, you slopes are clumsy."

Ngo: "Turned my ankle. It'll be okay." He wriggled the heavy boot tentatively. They waited at parade-rest stance, scanning blank storefronts. Silence.

Presently, Morse laughed. "So here we are in the late movie. The wagons are in a circle and it's midnight. I say, 'it's quiet.' Give me the next line, Norm."

"And I say, 'yeah, *too* quiet.' Right?"

"You two are real bundles of sunshine," said Ngo, still favoring the ankle, chortling through it.

Two minutes later the convoy arrived, speeding stealthily past on purring electrics. It was not as foolproof as supply by helicopter, but the choppers guzzled too much fossil fuel and the electrics were ideal for heavy cargo carriers. The last was a squad pickup van, slowing to take on gumba trios. Morse and Weintraub helped Ngo scramble onto the pickup platform, hauled him aboard, joked as they moved down the street toward the power station.

A cop in a full streetsuit cannot perform stevedore chores easily. By the time they unloaded the last crate in the power station, most of the squad reeked of sweat despite their conditioners. Weintraub, standing next to Morse, let his helmet swing from its hinges as he cocked his head toward his gumba. "What was that? What?"

Morse, grinning: "Just a gut-rumble. Something I ate."

"Bullshit; something you didn't eat."

"Sounds to me like he's smuggled a pet coon into his suit," said Ngo.

Sadler, his dark face gleaming with honest perspiration, was not quite out of earshot. "Who said *coon*? Whothefuck said that?"

"Poon, Sadler, poon," Weintraub said quickly. "Relax, pal; save your hostility for after lunch."

"What for? It was a cool operation, we go back to Center after lunch."

"Shit we do," from an amused Torre. "Gumba, don't you ever listen to the loo-tenant? We deploy here again for the rest of the supplies."

"Two convoys to the same place, same day," said Sadler, shaking his head. "It's not ess-oh-pee."

"Scumbags know that too. That's why we're doing it, I imagine," Morse explained.

"I guess." With his easy agreement, Sadler discharged the small obligation he felt to Morse. Then he sauntered in the general direction of the food serving line.

No one actually hurried to be served. It was a point of honor to deny hunger, though a third of the squad would miss at least one meal on any given day. But you never missed lunch on your shift. The city took care of its finest—once a day.

Weintraub made his patented funny-wry face at his tray. "Exigencies of the service," he sighed, and wolfed his clam strips along with the creamed potatoes, the mystery custard, the green salad. Morse had an outsized portion of everything. He ate methodically, dropping most of the meat into his lap without looking. He glanced to his right and caught Burgess Ngo covertly watching him.

"Don't say it," Morse muttered.

A scrutable smile: "Nothing to say, gumba," in mild protest. "Personally I can't stand the stuff either. I don't suppose you'd take my tray back, let me rest this ankle . . . ."

Ngo's clam strips lay artfully hidden in cream sauce. Morse grunted and took both trays. He had time to stuff Ngo's clams into his little stash bag. Well, it was a minor infraction. It might also be supper enough for—more than enough for one.

In the john, Morse tucked the bag into a pocket sewn into his shorts. The precious contraband made a heartbreakingly small package. It was not the first nor the tenth time Morse had done it.

As they redeployed on the street, Weintraub was surly. "You're more trouble than you're worth, Slope. Should'a reported in with that ankle."

"And lose a half-day? No way."

"Here they come," Morse called. Far down the street, now rounding a corner, a cargo vehicle picked up speed toward them. Three others followed, including the empty pickup van. Morse opened his mouth to make a suggestion—and kept it open. He felt the thump through his feet, saw the shockwave fling its ghostly dust-ring, before he heard it. The pickup van caught a concussion device squarely on its armored sidewall and toppled like a toy, fell on its side, slithered to a stop trailing sparks. Morse was running toward the explosion before he realized it.

The second concussion was nearer and heavier, less audible, a distinct slap against boot soles. A section of the street erupted, mined from beneath. Some scumbag had put an old sewer to good use.

The first two supply vehicles had already passed but the third, irrevocably committed by its mass and velocity, skidded into the gaping trench that now spanned the street. Its entire front suspension was swept away as it encountered the trench, slammed down, the inertia of its load carrying it forward, spinning crazily as it came to rest. Cargo crates spilled into the street and even from a hundred meters away, Morse recognized the tinned beef labels.

Morse took cover until the rain of debris subsided, jerked his head around at Torre's call: "Not yet, Sadler! Appropriate force, the man said." Sadler had been reaching for his carbine.

Sadler cursed and complied. The doctrine of appropriate force had peculiar applications. You could throw a stun grenade, which might do more harm than a plastic bullet, because the enemy had demonstrated his willingness to use explosives. But if some scumbag intended to deploy his people openly,

he knew better than to issue firearms. The sheer firepower and the dye of strike force ammunition created too many problems for mobbers to handle. So they thought up tactics that were nastier than bullets.

Morse sprinted up the street, outdistancing his gumbas, pacing the long-legged McEachern who was bawling into his intercom for a support vehicle. Both men saw the stream of jelly that lofted across the street ahead of them and splattered on macadam. McEachern veered toward the doorway from which the high-pressure stream had come, but he was a heartbeat too late with his staff.

A towering barricade of flame emerged from the doorway and raced across the street an instant after Morse leaped across the treacly stuff. Morse calculated that the napalm would burn away in half a minute. He did not yet know about the phosphorus and the titanium compound that would mask him from his fellows by a wall of white smoke.

Heart pounding, Morse loped to the supply van, clipping the long staff to his shoulder. First priority: victims of mob violence. He wrenched at the driver's door, ignoring the half-dozen mobbers who had already materialized, were throwing goods from the rear of the van.

The driver was a woman, inert against the windshield, a chunky flaccid burden in her police coverall. The damn' fool had not been wearing her helmet. She was breathing but a trickle of blood issued from one ear. Morse lifted her with a standard fireman's carry, lashed out with one arm as a mobber ran past, trotted quickly to the curb and eased his burden to the sidewalk.

"McEachern, get the other driver," Morse shouted. The big man was flailing with his activated mob control staff at the rear of the van. Two mobbers lay stunned underfoot. McEachern wasn't listening. Be-



hind them, a barrier of white billowed up from a sizzle of bright flame. Nobody was coming through it.

A streetsuited figure lay silent, sprawled grotesquely in police armor, and nearby a mobber of medium height moved frantic hands over a mob control staff, trying to activate it. Morse ignored him-or-her; mobbers usually wore handmade padding under coveralls, and some wore respirators under their rubber halloween masks. Thank God, Morse thought, the safety catch on that staff was a strike force secret.

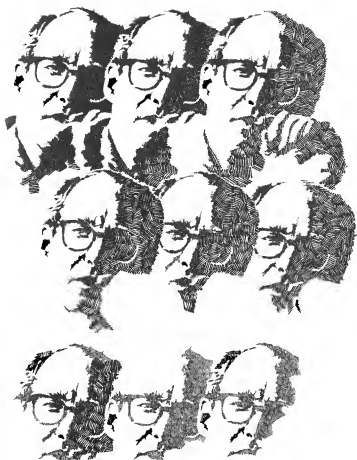
The pickup van was empty. Morse found the driver lying in the street, beyond help, and turned toward the fray where McEachern now battled three mobbers while several more escaped with food.

"Help is on the way," Morse shouted on the loud-hailer circuit. Even if it wasn't true, the idea might cause the mobbers to scatter. He used his staff on one mobber who'd circled around McEachern, oblivious to Morse himself. The man went jerking and shuddering to the macadam with one jolt.

Then Morse felt a tingling tremor, simultaneous with a heavy blow over his rib pads. The suit protected him from most of the amperage, but as Morse turned to face his assailant he knew the stolen staff was activated. If it caught him on a zipper or a metal joint it could jolt him unconscious.

Morse whirled, dropped into approved combat stance, fainted with his own staff and then tried for a quick disarming sweep. He often practiced the maneuver as a calisthenic when off duty.

His enemy seemed almost to expect his move, avoided his sweep, dodged with balletic grace. Morse waited for the next blow and, when it came, let his opponent's staff slide down his own. His gauntlets were insulated, and that was his great advantage. In an instant he gripped the mobber's staff with both hands, jerked it toward him, then flung it back with-



out letting go.

For a fleeting aeon the mobber's face was against his visor, eyes slitted through mask eye-holes. They stared in mutual murderous rage until Morse began his abrupt savage push-pull that shook the mobber like a doll, long hair spilling from the neck of her coverall, half obscuring the woman's mask with its rictus of hatred and despair and, in the blue eyes, something else.

Abandoning the unequal contest she leaped away, rolled, managed to parry Morse's savage kick with her hand, scuttled away holding her battered mask more or less in place. With her good hand she paused to fumble several cans of food into capacious pockets, keeping well clear of Morse as he shambled back to McEachern's side carrying both staffs.

Then Morse saw a broad armored figure hobble through the smoke, knew that Slope Ngo had taken extra chances to atone for his injury. The heel of his boot was on fire, but the heavy insulation might protect him.

McEachern went down, a mobber lasso encircling his staff. The cord snaked around the big man's legs as two husky mobbers hauled him writhing on his back from the vicinity of the van.

Ngo waded into the two mobbers with his staff, evidently using it without the jolter, as always the last man on the squad to escalate to appropriate force.

Morse took a stand before the rear of the van, calling for reinforcements as he waved a skulking mobber away. With Ngo's help, McEachern struggled to his feet again, pawing at his visor. The fall had ruined his suit conditioner and without it, a streetsuit got stuffy very fast.

"Your boot's still on fire, Slope," Morse warned, slowly advancing on two of the remaining three mobbers who seemed uncertain, now, whether to

continue the raid. Ngo allowed one mobber to haul the other away. He leaned on his staff, peered down at the boot, levered his visor up to get a better look. That was when the third mobber, the woman, flung the tin of beef.

Her missile took Ngo under the edge of his visor, impacted into his unprotected face. Ngo went down instantly, silently, sprawling on a scatter of food tins. The woman scrambled to secure several more tins, then fled with the springing leap of a doe as Morse drew near. He took a stun grenade from his beltpac, judged that it would land far enough from his gumbas, hurled it. The mobbers were on the run now but, with a good toss, Morse could flatten the woman and two others.

But the fight had sapped his strength and his will. The grenade fell short, its shocking blast no more than a heavy push speeding the woman in her flight. Morse saw Weintraub and others advancing through the smoke then, and knelt beside his fallen gumba.

Clumsy in his gauntlets, Morse thrust Ngo's visor away; saw the ruined cheek, the nose torn apart, the broken teeth. He ripped off his gauntlet, laid his naked palm on Ngo's still unbloody forehead, and fought the shakes that threatened to consume him.

Morse was only half aware, automatically going through the right motions, when he helped Weintraub shift Ngo onto a stretcher. All the time, and during most of the trip to City Center, Morse remained numb with his waking nightmare. The great millstone churned in its track behind his eyes, unstoppable, filling his awareness, and now he saw that the vast wheel was much larger, infinitely larger, than he had thought. It was taller than trees; mountainous. And it ground exceedingly small.

When she saw that Gary had finished his clam strips, Fran Morse put down her fork. "So soon,

greedy gut? Don't tell me you want more."

"Lounging around all day in the park is hard work," he said, trying to grin.

She gave him her I've-got-a-secret smile: "What if I told you there was mincemeat pie?"

"I'd figure you finally got a package from your folks, or more likely just setting me up for a gagline."

He watched as she went to the jury-rigged evaporation cooler, lifted its damp canvas flap, reached into the cool dark recess. She was turned away from him but he detected the patchwork cunning in her voice. "I got lucky at—the market today," she said, busy with her slicing. Then she turned with a demi-pirouette, revealing a saucer, and placed it before him. She returned for a second saucer. Each was piled with a dark mass of mincemeat pie, the glorious olfactory tang of autumn spices making him salivate even before he tasted it.

Fran grasped her fork awkwardly, drew a hissing breath, changed hands. She surrounded her first bite in mock ferocity.

Gary held the first bite in his mouth. He always made his first bite a small one, to make good things last. He'd forgotten how good—how deliriously, almost sexually delicious—food could taste. "Ah lordy, it tastes homemade," he marveled. "I wonder where they get the meat."

"What's all this 'they' business? It *is* homemade, with these two maladroitness hands," Fran said, carving another bite. "Even if I did have to start with Spam."

Somehow, forcing himself to chew, he managed to swallow the stuff. He looked up to find her eyes on him, unflinching, all-accepting; and when he put down the fork with, "Too rich to eat all at once," he knew his lie was obvious.

She accepted the lie too; stood quickly when she saw the change come over his face; moved to his side. Gary buried his face against the firm swell of her

belly. He felt the strong slender hands sweep through his hair, moved his own hands up and lifted Fran as he stood. The pallet was only steps away and he summoned enough strength to get there, unaware of the need to summon that strength.

For long minutes they lay together in the shadows, making no demands, sharing. "There will be better days," she whispered at last. "How are—the others?"

After a pause he husked, "Burgess will probably make it. Talk about *your* day, okay?"

"Let's just say it was profitable." She held her hands out in a *comme ci, comme ça* flutter. He caught one hand gently by the wrist, studied the shadings of an angry sunset in the dreadful bruise that spanned her thumb and forefinger.

With infinite tenderness, he brushed the swollen flesh with his lips.

She chuckled, "Just be glad you didn't catch me in the side of the head," and realized her mistake only when she felt him shudder.

"I am glad, and I'm sorry, and for God's sake *don't* talk about it," he muttered, shaking. Again he pleaded, "Tell me about your day."

She knew a moment of terror as she stroked the heavy shoulders, recalled the power they could command. Yet the moment passed as Fran Morse began, crooningly, to spin a tale of the day she might have had.

Gary Morse closed his eyes and tried to concentrate on Fran's account. Anything—her most desperate fantasy—was better than a return to his own inner recesses and the millstone that churned inside him. He could understand it now that he knew its size, recognized the grist beneath it as a billion upturned faces soundlessly screaming. He understood it all but one detail.

*Why, he wondered, must they all have my face?*

—Dean Ing









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**NEW**

**THE  
PROPER  
STUDY OF  
MANKIND**

**BEGINNINGS**

by  
**JE. POURNELLE**  
PH.D.

KNOW THEN THYSELF,  
PRESUME NOT GODS TO SCAN  
THE PROPER STUDY  
OF MANKIND  
IS MAN.

—Alexander Pope

We science fiction people often preen ourselves over SF's successful predictions. The famous visit by the FBI to John Campbell's office during World War II; rockets and space travel; TV; etc. And in fact we haven't done too badly in the technological forecasting business; no worse than anyone else, anyway.

But we don't often mention our "predictions" in the social sciences.

Remember the Golden Age of science fiction? Those were the days when "psycho-history" was an exact science using real math; computers manipulated the calculus of values, and matrix algebra, and all that good stuff. Psychiatrists "cured" criminals; judges were physicians, not lawyers. The social ills of the nation, the world, aye, the universe were plugged into computers (big, massive ones, not the dinky little things IBM and DEC make nowadays) and lo! the answers came forth.

Those stories had their effect, at least on me: I decided I was going to be the Hari Seldon of the XXth Century. I wanted to use the very best tools available, so I studied math and physics and hard sciences, then formal logic and Boole's Laws of Thought, and Carnap's sentential calculus, and once I was tooled up came a perfect orgy of psychology and sociology and anthropology that ended with what used to be called a "terminal degree" (meaning that thought ceases

with the Ph.D.?)

I studied psychology at the University of Iowa, where they had not one but two schools of psychology, Hull's pseudo-mathematical "learning theory", and Kurt Lewin's "vector psychology." I kept wondering when they were going to *use* mathematics. Surely, thought I, there would come a time when they would give rigorous definitions; but no, what happened was that they took mathematical symbols and let them stand for some perfectly good English words—but without improving the precision of their definitions one whit. And even when they played math games with the resulting symbols (none of which could *really* be quantified), the most complicated function I ever saw was a simple algebraic equation.

But then there was statistics. That, we were told, is a tough subject. Well, given that it was taught daily at 0700 by a professor of education, it *seemed* tough; but in fact all that was taught was cookbook stat, how to compute mean, median, mode, standard deviation, and the like; and how to do cookbook tests using Student's "T-test", and a peek at the Chi-square—not at the Chi-square *distribution*, of course. Heaven forbid that psychology students learn real mathematics; so actual calculations of probability not covered in the cookbook were beyond my classmates, and I suspect that if you ask the average Ph.D. in psych or sosh or anthro or ed what a probability density is, you'll either get a blank stare or hear something mumbled about specific gravities.

In due time I wandered to the University of Washington. (Accident certainly plays a large part in one's life: I was in school on the Korean-type GI Bill, which paid a fixed sum per month; I hadn't lived with my parents since a year before I graduated from high school, but to save money I had to go to a state university as a resident; my parents had gravitated to

Alaska, but the state of Washington had generously declared residents of Alaska to be Washingtonians; and therefore . . .)

The psychology department at the University of Washington had its schools too: one was headed by a maniac who'd spent twenty years in the attic studying conditioned reflexes in chickens. The best-known man at Washington was Edwin Ray Guthrie, one of the "big three" in learning theory; at Iowa they'd taught us he was not merely wrong, but stupid. (My own opinion is that he was the only practical psychologist in the theory business; his theory can be stated in two sentences, and his practical deductions from the theory are almost absurdly simple; but they can be applied—and they work. That's another story for another time.) And finally there were a couple of professors who actually understood something of mathematics, and who seemed determined to apply real scientific method to the study of man.

One was Paul Horst, who had a contract from the US Navy; he was trying to predict the four-year grade point average of entering freshmen. Lest Proxmire read this and retroactively award Dr. Horst a Golden Fleece, let me point out that the Navy had—and has—a damned legitimate interest in predicting academic success. It costs a lot of money to send a recruit through specialized training such as electronics school; if you can choose from among the boots those likely to do well in the school, you'll save the cost of Dr. Horst's grant in no time.

Those were heady days. Horst's approach to the problem was to get every possible measure on every entering freshman, wait until they graduated, then flog hell out of the data. The goal was to find a series of weights to apply to each predictor such that when you did all the addition and multiplication you had an adequate prediction; and to do that for each of thirty possible majors! Here finally was a legitimate

use for matrix algebra, which Horst required all of his students to take.

We also went to computer school, because inverting a 60 x 60 matrix is hairy. Of course the best computers in the world weren't very good; IBM thoughtfully gave the school a 650, but there weren't any programs to do what we wanted, and we grad students had to learn programming: not in easy languages like Basic or Fortran, which didn't exist; not even in modern assembly language; no, we had to do it in machine language.

Eventually it was done. (My part, as I recall, was a program that would invert triangular matrices; it took a whole summer to develop it, too.) Came the day when the great grade prediction program was to be run. Since the 650 had rather limited memory (on a drum at that) the programs made it punch intermediate answers on cards, which were then carried from the punch to the reader to be fed in again; we were up all night getting just part of the answer. But at last we had the equations: take an incoming freshman, subject same to a battery of tests, plug in high school grades and class standing, plug in a correction for the particular high school (and save the data, because that correction factor needed more cases from each school to give it more accuracy); put that into the computer; and out came a prediction of the grade that student would get after four years in each of about 30 major subjects.

Only predictions, of course; now there was nothing for it but to wait four years and let those students graduate. Obviously each case would count only toward the predictions made for the major actually chosen; but enough of those would validate the predictors. Eventually there'd be enough data to validate the method used.

I'd left before the first students graduated, but I'm told it looked very good indeed; good enough that the

University decided to give incoming students their predictions to help them choose majors.

And it hit the fan.

I don't know the current status of the grade prediction program at the UW now; I gather it's moribund. It seems the predictions were racist. They were detrimental to some of the high schools (remember that correction factor?). They were also detrimental to certain departments, because they showed that students almost certain to flunk out in one of the difficult majors would do well in many of the soft sciences . . . (In certain majors there was not one single predicted flunk.)

So what's the point of all this?

Two points: one, it may just be possible to do really useful stuff in the social sciences; and two, it takes a lot of time, and it takes a lot of money; and if time and money shortages don't discourage that sort of thing, the next factor is almost certain to: it's *hard work*. It takes real knowledge of real hard stuff; much harder than sophomore stat and freshman calculus.

And do they require that sort of thing in social science departments? They do not. What they do require for a Ph.D. in psych is "History of Psychology"—a course in which you're required to learn, in great detail (the textbook was written by a man named Boring; portent enough, but the reality was worse), what all the "great thinkers" of the field believed. At the end of each section you find out why they were all wrong. It's as if to get a degree in chemistry you had to spend months learning about the phlogiston theory; as if physics required a three-week course in Democritus' beliefs about atomic structure. In other words, this required course is a confession: the discipline has so little content that they've invented this artificially difficult barrier so the doctorate won't be so easy to get.

Nor is that all: you can spend an entire quarter



debating the difference between a "hypothetical construct" and an "intervening variable", a subject worth perhaps five minutes; you can learn a jargon designed to make your conversation incomprehensible, and which serves no purpose other than to see that someone from another discipline will be discouraged from trying his hand; and when it's all finished you are qualified to do what?

What indeed? What is a person with an undergraduate degree in psychology capable of doing? And psych is the tough one; if a B.S. in psychology is aptly named, what are we to make of sociology?

But maybe it's all just as well. Do we really *want* social science? Let me illustrate.

Probably the most controversial subject in the field involves IQ tests. What, if anything, do they mean? And since most IQ tests show a statistical difference between the races, shouldn't their use be forbidden? (Some courts have forbidden their use in university entry decisions for precisely that reason.)

And my Lord, the arguments that can develop! Nature versus nurture. Heredity versus environment. I listened to a paper on the subject presented by a Harvard professor at an AAAS meeting a couple of years ago, and by Roscoe the debate hasn't moved an inch since my undergraduate days.

Yet it wouldn't be hard to settle, would it? Not if the answer really were wanted.

When I took social sciences seriously, one experiment reported in the Tests and Measurement courses seemed really elegant: the twin studies. It's a simple experimental design. First locate a number of pairs of twins. What you want is identical twins reared together; identical twins reared apart; fraternal twins reared together; and fraternal twins reared apart. Those reared together shared roughly the same environment; while identical twins have identical hered-

ity, unlike fraternal twins who are no more closely related than any other siblings. Go find a number in each category; not easy, but not so very difficult in this era of forms and dossiers.

Give them a number of tests. Ideally test everyone in their class at school, or job category at work, so that your subjects don't know they've been singled out. Then compare the results. What you're looking for is not absolute IQ, whatever that means, but point spread between pairs.

My Differential Psychology text reported such an experiment, and lo! the results were unambiguous. The least difference between pairs was identical reared together, as you'd expect; but then came identical reared apart, not fraternal together—suggesting strongly that heredity was more important than environment in determining what was being measured by the IQ tests.

I'm told that the classic experiment reported in my book was in error; that some of the data may have been fudged. Okay. That's possible. But instead of long debates with anecdotes, and speculations on whether those data were fudged, why not go do it again?

While we're at it, why not develop a really good grade prediction program? The computers exist. Lord knows there's enough money spent on tests. And there must be IQ data on millions of graduates of tax-supported institutions; that can be followed up to see if all that testing is worth anything. If it is, fine, use it to save time and effort and money; if not, fine again, abolish the silly tests; but what we actually do is ridiculous.

Maybe we don't want successful prediction? Might good predictions of academic success have a baleful effect on the republic?

Aha. We're now in the realm of political "science", which once a long time ago meant the study of politi-

cal philosophy and involved a great deal of history; nowadays the rage is "behavior", meaning that what was faddish in psychology twenty years ago has now caught on in poly sci; with about the same utility. Not that all political science courses are a waste of time; there's considerable value in discovering that most of the ideas and movements and problems we think are unique to our age have cropped up again and again in other times and places. One can also learn something about statesmanship and diplomacy, and even a bit about how to win an election. But there's damned little science in it.

There's sometimes not even common sense. Take the business about a political "left" and "right". It's easy to prove it's nonsense. There's absolutely no variable underlying that "spectrum"; indeed, I pretty well proved in my dissertation that it takes at least two variables at right angles to each other to map even the broadest political groupings each to a unique point. The whole idea of a "left" and "right" is nonsense—but it's still with us, and it has important consequences in the very real world. What in the world do British labor unions have in common with Soviet communism other than the vague feeling that both are "the left"? Are the Czechs better off under Soviet occupation than they were under the Nazis? Of all the stupid notions in academia, the "left-right" model of politics is demonstrably among the silliest; to flog an already-used example, it's as if the chemistry department allowed the rest of the faculty to act as if they believed in phlogiston. If political science can't manage even to stamp out that nonsensical notion, what can it do?

And that at last brings me to the point of this polemic.

There isn't any "social science". None. There are no experts, not in the same sense in which one can be an expert in physics, or chemistry. To the extent that

science fiction has encouraged the notion that a science of human behavior exists, we have harmed the world.

We can survive the sociologists. We may even be able to survive the psychologists. The political scientists are a bit more dangerous, but they don't have all that much power: mostly I think of good they could do (like using freshman poly sci to dispel some of the nearly-universal nonsense) and sigh over the waste.

Economists are another matter.

"It ain't what we don't know that hurts us, it's what we know for certain that ain't so."

The economists think they know. And between them and the lawyers, they run the country.

Hope springs eternal. Even after discovering that the useful content of academic psychology can be learned in under a year, and that political science, while enlightening and valuable for intellectual stimulation, was less scientific than psychology, I still yearned for Hari Seldon's laws. Perhaps economics? Economists at least say they're scientific. Grad students in economics talk about input-output models, aggregate economic analyses, "fine tuning" the economy; even in my day, they had complex equations systems which, once they had computers, they could solve . . .

Alas, it's worse there than elsewhere. Look at some of those splendid computer models—and look at the results. They don't predict a damned thing. Hell's bells, as I write this they're wondering whether we're in a recession or not! Now sure, economists can *explain* everything after it's happened—but so can any of the social sciences. And the trouble with acting as if economists have some special knowledge is that they get in the way of common sense.

Look: it doesn't take much genius to see that minimum wages cause unemployment of the un-

skilled. You wouldn't hire at three dollars an hour someone capable of doing only two dollars' worth of work; why think anyone else will? Now sure, politicians might act cynically: raise the minimum wage, and count on inflation to negate the effect; but that's not science.

It's not a lot harder to see that high taxes encourage people to spend rather than save; if you want to curb inflation, reduce the tax rate.

They give Nobel prizes in economics. The award is political, of course; people with diametrically opposite views have won it. If one's right, the other must be wrong. Or they both are.

The theory of state-supported education is that it's an investment in the future. The future citizens should have intelligent opinions and useful skills.

Some think this is the most important investment we can make.

So who allocates this most important investment? Why, the people objectively least qualified to do so, of course: incoming freshmen. Department budgets are closely correlated with number of majors. Thus we have a kind of oriental bazaar, with each department trying to woo as many of the frosh as possible. Each also wants to have one or more courses required for graduation; that too boosts enrollment and thus budget.

There's another way.

Wouldn't it make more sense to subsidize departments in proportion to the republic's need for their graduates? And while we're at it, to use our new powerful computers to generate really good predictions of success in the field? Now true, that would mean some students wouldn't get into the department of their first choice; at least not at public expense. But is that any worse than the present situation, which looks like a bad parody of manpower

allocation?

Over five years ago I was asked to testify to a legislative committee investigating diminishing resources; at the time I said the most critical diminishing resource was trained talent. I've had no reason to change my opinion.

In the 50's we thought it shameful that almost 20% of our population was in some degree illiterate. We debated what to do about it. The social scientists promised that all it would take was some Federal Aid to Education; a couple of billion dollars would solve the problem nicely.

Three years ago we lamented our 30% functional illiteracy. Now we have a Department of Education. When do we reach 50%? Anyone want to bet we won't?

Mrs. Pournelle is a reading specialist; her students are illiterate teen-agers, many of whom have thick files proving "scientifically" that they can't possibly learn to read. They've "got dyslexia" (which translates to "reading difficulties"; reminds me of my friend who was much relieved when the physician told him his lower backache was lumbago). She tips the files into the waste can and teaches the kids to read. She is also required by law to take various university classes on how to do her job; thus I'm exposed to the journals and textbooks, and they are simply unbelievable. What passes for research would be laughable if it didn't cost so much—and so thoroughly affect people's lives.

So what's to be done about it? I don't know. My agreement with Baen entitles me to an occasional tirade, and this has been it. Years ago E. C. Banfield said, "The existence of a body of nonsense which is treated as if it were a grand principle ought not be regarded by reasonable critics as equivalent to a grand principle," and I'd like to think I could per-

suade some of the more honest academicians to take that seriously.

Because it is serious.

We have big computers now. We have analytical tools which might, just might, allow some real science in the social sciences. Hari Seldon's psychohistory probably isn't possible; but something short of it may yet be developed by people trained in scientific method and equipped with modern tools; who know something of computer science and the capabilities of both large and small machines, and also know enough mathematics to have something to program.

But that won't happen if we continue to insist that students learn the nonsense that fills today's social science texts. If they spend their time on nonsense they won't have time to learn anything else.

## All Ends Of The Spectrum

### An Appendix

One reason Jim Baen keeps me around is that he likes to talk. We have endless telephone discussions of column topics, and they tend to spill over to anything else going on. In the course of one conversation we got to the subject of the Ayatollah Kockamamie, and Jim said something about "all ends of the political spectrum . . . er, points."

"Curious you should put it that way," I replied. "I wrote my disseration in political science on a proof that the political spectrum has more than one dimension; that the old left-right category doesn't really work."

"Now there's a column," Jim said. And on reflection I agree. At least it makes a good appendix to my tirade on what's wrong with the social sciences.

The notion of a "left" and a "right" has been with us a long time. It originated in the seating arrange-

ment of the French National Assembly during their revolution. The delegates marched into the Hall of Machines by traditional precedence, with the aristocrats and clergy entering first, then the wealthier bourgeois, and so on, with the aristocracy seated on the Speaker's right. Since the desire for radical change was pretty well inversely proportionate to wealth, there really was, for a short time, a legitimate political spectrum running from right to left, and the concept of left and right made sense.

Within a year it was invalidated by events. New alliances were formed. Those who wanted no revolutionary changes at all were expelled (or executed). There came a new alignment called "The Mountain" (from their habit of sitting together in the higher tiers of seats). Even for 18th Century France the "left-right" model ceased to have any theoretical validity.

Yet it is with us yet; and it produces political absurdities. No one can possibly define what variable underlies the "left-right" continuum today. Is it "satisfaction with existing affairs?" Then why are reactionaries, who most definitely want fundamental changes in the system, called "right wing"? Worse, the left-right model puts Fascism and Communism at opposite ends—yet those two have many similarities. Both reject personal freedom. Some would say they are more similar than different.

What are we to make of Objectivists and the radical libertarians? They've been called "right wing anarchists", which is plain silly, a total contradiction in terms.

Nor is this all academic trivia. "There is no enemy to the Left" is a slogan taken very seriously by many intellectuals. "Popular Front" movements uniting "the Left" (generally socialists and communists) have changed the destinies of nations. Conservatives swallow hard and treat kindly other members of "the



Right" even when the others seem despicable by Conservative standards. The left-right model, although nonsensical by any theoretical analysis, has had very real political consequences.

Some years ago I set out to replace the old model with one that made more sense. I studied a number of political philosophies and tried to see what underlying concepts separated them from their political enemies. Eventually I came up with two variables. I didn't then and don't now suggest these two are all there is to political theory. I'm certain there are other important ones. But my two have this property: they map every major political philosophy and movement onto one unique place.

The two I chose are "Attitude toward the State", and "Attitude toward planned social progress."

The first is easy to understand: what think you of government? Is it an object of idolatry, a positive good, necessary evil, or unmitigated evil? Obviously that forms a spectrum, with various anarchists at the left end and reactionary monarchists at the right. The American political parties tend to fall toward the middle.

Note also that both Communists and Fascists are out at the right-hand end of the line; while American Conservatism and US Welfare Liberalism are in about the same place, somewhere to the right of center, definitely "statists". (One should not let modern anti-bureaucratic rhetoric fool you into thinking the US Conservative has really become anti-statist; he may want to dismantle a good part of the Department of Health, Education, and Welfare, but he would strengthen the police and army). The ideological libertarian is of course left of center, some all the way over to the left with the anarchists.

That variable works; but it doesn't put all the political theories each into a unique place. They overlap. Which means we need another variable.

"Attitude toward planned social progress" can be translated "rationalism"; it is the belief that society has "problems", and these can be "solved"; we can take arms against a sea of troubles.

Once again we can order the major political philosophies. Fascism is irrationalist; it says so in its theoretical treatises. It appeals to "the greatness of the nation" or to the *volk*, and also to the *fuehrer-prinzip*, i.e., hero-worship. Call that end (irrationalism) the "bottom" of the spectrum and place the continuum at right angles to the previous "statism" variable.

Call the "top" the attitude that all social problems have findable solutions. Obviously Communism belongs there. Not far below it you find a number of American Welfare Liberals: the sort of people who say that crime is caused by poverty, and thus when we end poverty we'll end crime. Now note that the top end of the scale, extreme rationalism, may not mark a very rational position; "knowing" that all human problems can be "solved" by rational actions is an act of faith akin to the anarchist's belief that if we can just chop away the government, man truly free will no longer *have* problems. Obviously I think both top and bottom positions are whacky; but then one mark of Conservatism has always been distrust of highly rationalist schemes. Burke advocated that we draw "from the general bank of the ages," because he suspected that any particular person or generation has a rather small stock of reason; thus where the radical argues "we don't understand the purpose of this social custom; let's dismantle it," the conservative says "since we don't understand it, we'd better leave it alone."

Anyway, those are my two axes; and using them does tend to explain some political anomalies. For example: why are there two kinds of "liberal" who hate each other? But the answer is simple enough.

Both are pretty thorough-going rationalists, but whereas the XIXth Century Liberal had a profound distrust of the State, the modern variety wants to use the State to Do Good for all mankind. Carry both rationalism and statism out a bit further (go north-east on our diagram) and you get to socialism, which, carried to its extreme, becomes communism. Similarly, the Conservative position leads through various shades of reaction to irrational statism, i.e., one of the varieties of fascism.

On the anti-statist end of the scale we can see the same tendency: extreme anti-rationalism ends with the Bakunin type of anarchist, who blows things up and destroys for the sake of destruction; the utterly rationalist anti-statist, on the other hand, persuades himself that somehow there are natural rights which everyone ought to recognize, and if only the state would get out of the way we'd all live in harmony; the sort of person who thinks the police no better than a band of brigands, but doesn't think that in the absence of the police, brigands would be smart enough to band together.

The whole thing looks like Figure One. (Page 49)

Now I do not claim this is *the* model of modern politics; I do claim that it is a far better model than the one we're using, and in fact I go farther and claim that the "left-right" model so ubiquitous amongst us is harmful. And while I understand that some ideologues find the "left-right" model useful to their cause, and thus have a powerful incentive to gloss over its failures, what puzzles me is why so-called objective political "scientists" don't try to abolish it, at least in freshman political science classes.

But then I've already admitted I don't understand the "social sciences" to begin with, and I needn't say all that again.

Next issue real science. My promise.

## EDITOR'S NOTE:

Never before have I felt called upon to add to one of the redoubtable Dr. Pournelle's columns, but Jerry has been guilty of that most heinous of auctorial sins: modesty.

Seriously, Jerry seems to have come up with a useful, predictive, *scientific* measuring device for the social so-called sciences, and passed it off as an "Appendix," forsooth! In politics alone the results of the widespread use of the Pournelle Axes would be revolutionary: pols would be required not only to declare themselves but to reveal precisely and literally their political position—and live with it. For example Teddy Kennedy from his own pronouncements cannot be less than a 4.5/4.5'—how many people in this country would vote for a 4.5/4.5' once it was revealed for what it was? Give me a 2/4' any day! (That's what I am; once you have analyzed your own position, you may find your own political choices becoming remarkably simplified. Reagan and Crane, both at 4/2' make me a little nervous. Bush, at 3/3' looks pretty good.)

Note also the odd sympathy and support between the diagonally facing quadrants, as opposed to the antipathy between contiguous ones—at first blush diagonals would seem to make natural enemies, yet artists, intuitive by definition and anti-statist almost by definition, yearn for a world where true art is replaced by Socialist Realism—while *libertarians* provide the theoretical groundwork for right-wing dictatorships! Odd, very odd.

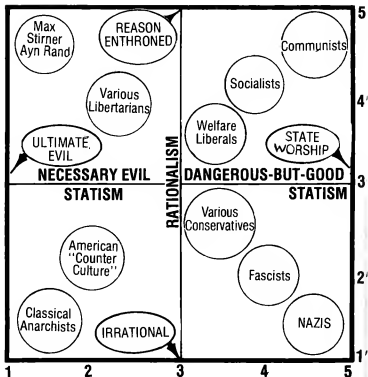
Note also how one can define "reasonable" as any position no farther from 3/3' than one's own: those farther out in one's own quadrant are pleasantly dotty; those farther out in another, unpleasantly so . . .

But it's not my aim to analyze the Pournelle Axes in

depth; any such attempt by me would be necessarily superficial. One of these days I'll get another column from him on this subject. My point is that for *this* column Jerry Pournelle is guilty. Guilty as sin. Of modesty.

—Baen

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# **THE TAMING OF THE BEAR:** THE COMING DECLINE OF SOVIET POWER

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**NORMAN  
SPINRAD**

THE GOOD NEWS IS  
that most of what happened  
to the United States  
in the 1970s is going to  
happen to the Soviet Union  
in the 1980s, and in spades.



First the bad news, then the good.

The 1970s saw a significant decline in American world power, both in absolute terms and in relation to our perceived potential "enemy" the Soviet Union. In the late 1960s and early 1970s, while the United States was pouring hundreds of billions of dollars down the rathole of Viet Nam, the Soviet Union was not only steadily increasing its military budget, it was *hoarding* its growing stockpile of ordnance rather than pissing it away on anything so counter-productive as an actual war.

In several ways, the United States has still not recovered from the effects of the Viet Nam debacle, and it is arguable whether it ever really will. In military hardware terms, the US bled itself white while the Soviet Union was building up its arsenal while spending less money on its defense budget. If what we spend on Viet Nam had gone instead into building up *our* military establishment, we would now have a military machine sufficient unto keeping the Soviet Union in a perpetual state of paranoid dread. In energy terms, the napalm expended alone would probably have been able to supply our total petroleum needs for years if we had burned the petrol used to make it domestically instead of dumping it on Indochina. As for the fuel expended by operating the world's most mechanized army at full bore for eight or so years, the mind boggles. B-52s, Phantoms, armadas of helicopters, tanks, boats, and ships, all running on oil, and burning it up as if there were no tomorrow. The War alone probably advanced the onset of our energy crunch by at least a good half-decade. In economic terms, the Viet Nam War was directly responsible for the birth of our ravaging inflation due to the deficit spending it created, and indirectly responsible for a goodly part of the energy component of continuing inflation due to the enor-

mous amount of petroleum it destroyed to no productive end.

The political dues we are now paying for our folly are if anything even worse. Our prolonged involvement in a David and Goliath act with a Third World country made us the propaganda villains of the planet irrespective of any real political issues or absence of same. Our ignominious defeat rotted away the confidence of those who had bet their survival on American power and will. Our horrified retreat from "the arrogance of power" inevitably over-reacted into a posture of impotence.

While this American nightmare dragged on, the Soviet Union built up its armed forces, found itself a foreign legion of Cubans, made propaganda whoopee at our expense, felt free to throw its weight around all over the world with impunity, and laughed up its sleeve at our assholery.

Now it would seem that the United States has entered a period of inevitable decline. Our international influence has waned, our military power has lost credibility, we are being looted economically by OPEC, we can't control our inflation, and the Red Star is rising, to hear the doomsayers tell it. Truly the days of America as the dominant world power are over.

That's the bad news.

The good news is that most of what happened to the United States in the 1970s is going to happen to the Soviet Union in the 1980s, and in spades. Before the decade is out, the Union of Soviet Socialist Republics is going to be a very different country. And there is some evidence that the Soviet leadership has known this for a while and has been acting accordingly.

Consider the SALT negotiations. Much has been made of how we have been snookered by the Russians on the SALT II treaty, that it will give the Soviet Union permanent military superiority in the area of

strategic arms. Maybe this is so, maybe it is not. The SALT II treaty is a complex and specific contract hammered out in tough negotiations one item at a time. Like a writer negotiating a book contract with a publisher, both sides were looking for the best deal they could get. Since there was a strong American desire to cut the defense budget in the immediate post-Viet Nam period, since the karmic flow was going against us, and since we sometimes doubted Soviet intentions while making our own rather transparent, the Russians were in a better psychological negotiating position, like a publisher who knows that a writer needs money, and it would not be surprising if it turned out that they got something of the better of the deal.

But like a writer and a publisher negotiating the fine print, both sides knew they were going to make a deal. Because both sides wanted it badly.

The United States wanted a deal for sanity's sake and also for vital economic reasons, areas which are not *always* out of sync. The Russians were high-balling ahead with gaudy new weapons systems, the momentum was with them, we were afraid of their growing world power, and to continue the endless strategic arms race with hope of matching them warhead for warhead and missile for missile would mean putting even more strain on our groaning economy. We needed arms control. The Russians knew we needed it. We knew they knew.

But no one—or hardly anyone—seemed ready to clearly ponder why *the Russians* really wanted a deal. Opponents of the SALT II treaty claim that the Russians wanted it to take advantage of our weakness to write us into a position of permanent strategic inferiority, under cover of which they would be free to make their moves. No doubt the Soviet Union would have been happy to achieve this goal in the bargain, but that wasn't why the Russians *needed* arms control

agreements. As I write this, the SALT II treaty has not yet come before the Senate, but whatever happens to this one treaty, you can bet that there will be an end to the strategic arms race before the 1980s are over.

Because the Soviet Union can afford its continuance far less than can the United States.

If we step outside our stereotype of the godless atheistic Soviet Communist would-be world-ruler and bear in mind that the old Russian Empire gave us world-class paranoiacs like Ivan the Terrible and Dostoyevski, we can see that much recent Soviet action can be seen as motivated by fear. Consider where these people are coming from.

The Union of Soviet Socialist Republics is the direct inheritor of the Russian Empire, by far the largest colonial empire ever put together, and the only one still doing business in the 1980s with even more territory under its dominion. The 16 so-called autonomous Soviet Republics contain scores of nationalities, about a dozen of which had nations, independent states absorbed by the Soviet Union as late as the end of World War II. The closest ally that the Russians have in this polyglot empire are the Ukrainians, and Khrushchev made his rep putting down a rebellion there as late as the 1950s. The Russians are already a demographic minority in the Soviet Union and before the 1980s are very old, the Russians and the Ukrainians combined will be a minority.

Communist ideological transnationalism and decades of a policy of geographic dispersion may have muted and faded these separate national identities, but the Soviet Union is still the Russian Empire in terms of who intends to keep running the show. The Russian Soviet Socialist Republic, the overtly nationalistic Russian state within this union of "equal" national states, stretches from Leningrad to

Vladivostok, and contains any number of "autonomous regions" inhabited by non-Russians without the clout for a first-class "Soviet Socialist Republic." Russians dominate the party, the economy, the government, and the army, as in the days of the Czars.

And they are being outbred by the "national minorities." Ultimately, if the Union of Soviet Socialist Republics is going to survive as a coherent political entity, the Russians are going to have to live up to their own ideal of communist transnationalism and surrender their colonial power to something closer to being representative of demographic reality.

Twenty million Soviet citizens died in World War II at the hands of a monster barbarian horde from the West, and earlier, a consortium of western nations had tried somewhat half-heartedly to strangle the infant communist state at birth. Small wonder then, that the Soviet Union has an honest fear of the West. We may know we'd never attack them like mad dogs again, but they have no particular reason to be sure of that.

Nothing breeds aggression like paranoia. Because the Soviet Union had good cause to be paranoid about hordes of Huns invading from the West, they rationally decided they needed a buffer zone between their borders and the western barbarians. For this purpose, they appropriated Poland, Hungary, Rumania, Bulgaria, Czechoslovakia, and a third of Germany as buffer puppet states. They almost got Greece and Yugoslavia too and once had Albania before things stabilized at the onset of the Cold War. With varying degrees of enthusiasm, they are still trying to pull satellites into their orbit in order to make the front lines recede as far away from them as possible. No doubt there is still some ideological enthusiasm for winning the Earth for World Communism in certain circles, but now that "World

Communism" includes their decidedly non-fraternal neighbor, the People's Republic of China, such enthusiasm needs be on the back burner while the realities of the international game need be dealt with.

Does it seem that the Russians are stretched a wee bit thin? A majority in their own empire, and still dwindling further demographically, they are also the suzerains of six nominally independent nations whose populaces have little reason to love them.

Time was, the Eastern European vassal states were a going colonialist concern. The Russians linked them to the Soviet economy by turning them into suppliers for the rebuilding of Mother Russia, preventing them from attaining anything like economic independence. Thus, the "Communist Slave Empire" beloved of American paranoiacs in the 1950s.

A slave empire it was, but in order for the slaves to work, they had to eat, and in order for them to produce for the greater good of the world communist movement, they had to have the means of production. Since production in the satellite states was for the good of Mother Russia, and since the Soviet Union was blessed with what seemed like limitless oil at the time, the satellite countries built their industrial economies on cheap subsidized Soviet oil.

Which is now beginning to run out.

The Soviet Union, like the United States, had enough domestic oil to take care of its own needs and then some until fairly recently in the industrial development game. Like the United States, the Soviet Union made no attempt to stretch its domestic supplies into the future by importing oil from abroad in the years when it was cheap and abundant. In the late 1960s and early 1970s, we had our oil potlatch in Viet Nam, a far gaudier display than anything the Soviet Union managed. But starting as far back as the 1940s, the Russians were pouring their oil into a

rathole of their own. A much more profitable rathole than ours to be sure, but the oil the Soviet Union used to subsidize their manufactories in Eastern Europe is still up the same flue.

Within the next few years, conceivably even as this is written, the Soviet Union will become a net importer of petroleum. And if you think that gives *us* problems . . . .

It makes the Soviet Eastern European vassal states a red-ink proposition. I mean, look at the books. As things will soon stand, if they don't stand there already, the Russians will be expending billions of rubles for an army of occupation in six fractious states some of whom have somehow managed to achieve higher living standards than those prevailing in the colonial power. Is this any way to run a Slave Empire?

Maybe it is. The Hungarians were bought off with prosperity to the point where Janos Kadar, the "Butcher of Budapest," thrust into power by the naked force of the Red Army, is now the hero of his country. East Germans not only live better than Russians, they've given them what for in the Olympics. Romania tells them to buzz off politically if they want economic cooperation. Even their latest victims, the Czechs and Slovaks, are more prosperous than the Russians.

In the 1980s, as Soviet weaknesses become more apparent, the Russians will want to hold onto Eastern Europe even more for security blanket reasons, but the cost of keeping things cool will really start to drain them. If the Russians pull out the plug on their oil exports—as sooner or later they will have to—the economies of much of Eastern Europe will become non-viable, and the relative peace that economic progress has brought will evaporate into chaos.

Even if there are no uprisings, the costs of economic linkage to Eastern Europe on the current basis will

eventually prove prohibitive, and what happens then is probably something the Soviet leadership would like to leave to their posterity.

You think the United States has problems? Then think who is forced to buy food from whom! In an atlas, the Soviet Union has a somewhat larger population than the United States and a land area immensely larger. But if you look closer, you see that much of this has a climate you don't even want to think about, and in fact the Soviet Union has had trouble feeding itself for some time now. This failure of Soviet agriculture has usually been attributed to the inferiority of collective farming to free enterprise agriculture, but you've got to think twice about that when you compare American agribusiness to Soviet collective farming from the point of view of the workers who have no ownership equity in either. The work is similar, and so are the economies of scale. The Soviet Union leads the world in the production of tractors; it's not some backward unindustrialized country. It's a smug, self-satisfied illusion to attribute the Soviet Union's failure to feed itself adequately on its own to the inferiority of its political system.

Fact is, the limits on Soviet agriculture come with the territory, no matter what the political and economic system is. In a golden bumper year when everything goes right, the Soviet Union can feed itself and have something left over for a little export maybe. In an average year, they can put together little deals around the world for the modest supplement they need to their own food production. In anything much below average, they are at the mercy of the United States. Much of the Soviet Union is frozen tundra, much of the rest of it is simply not suitable for growing grains. The total Americanization of Soviet agriculture might produce higher yields, but still not enough to equal American food production in a coun-



try with a somewhat larger population. When it comes to food, the Soviet Union simply wasn't dealt as good a geographic hand of cards as the United States.

This, then, is what the Soviet Union faces in the 1980s: growing dependence on imported oil, no prospect of food self-sufficiency, the economic unviability of maintaining its Eastern European satrapies, the demographic shift of population ratios against the Russians who are running the place, and a chosen enemy, the United States, which not only has the largest GNP in the world, but which somehow must be persuaded to continue to sell its adversary food. And to make matters worse, it faces, over a thinly-populated three thousand mile border, the People's Republic of China—the most populous nation in the world, a racial enemy since time immemorial, the destroyer of the Soviet dream of a world socialist order run from Moscow, a rival for disputed territory, and a country which now seems to have realized that it has no real conflict with the United States, and which is currently trying to persuade the US to join it in an alliance against "Soviet Hegemonism."

The Russians may have a long reputation for being paranoiacs, but who can deny that they have plenty to be paranoid about!

Surely the people in the Kremlin must be thanking their lucky red stars for Viet Nam. Without it, their situation would be even grimmer now, at least in their own eyes. While the United States was depleting itself economically and militarily in Indochina, they had a chance to prepare themselves for the 1980s as best they could. What we spent on a war, they spent on building up their forces. With a smaller economic base, they were able to forge ahead in numbers of conventional arms, achieve naval near-equality, and catch up in strategic arms. To some extent they did this by the simple expedient of forcing

a standard of living on their people lower than that of even some of their own satellite states, where such an excess of guns over butter would probably lead to a whole string of upheavals. But mainly, they were able to catch up to and to some extent surpass the military machine of a much larger economy because the United States gave them something close to a trillion dollar handicap.

If there had been no Viet Nam, and all the money the United States wasted there had gone into the American end of the arms race, the Soviet Union would have bled itself white trying to maintain any kind of parity with *that* behemoth. No way they could've done it.

There is no Viet Nam now.

And that is why the Soviet Union wants a SALT II treaty, and a SALT III, and beyond. At the end of the 1970s, the Soviet Union had achieved rough military parity with the United States, maybe even a little more, but it was a temporary situation that could not last if the arms race now continued. If the arms race continued into the 1980s, balance would inevitably shift more and more towards the United States, while a Soviet Union that was already stretched very thin economically and politically would either spend itself into exhaustion trying to keep up, or be forced to accept American military superiority.

The Russians cannot win any arms race. There is some evidence that they know this and are acting accordingly, trying to get out of the competition they can't win by ending it when conditions are more favorable to them than they ever will be again.

What then will happen in the decade of the 1980s as the Soviet Union comes up against its geopolitical and economic limits as the United States did a decade earlier?

Well for one thing, they didn't build up that big

military machine to do nothing with. There may be nothing they can do about their dependence on American grain, but they certainly have long had plans to increase their oil supply by gaining access to what lies not too far from their southern borders in the Middle East.

As things stand now, they've been pretty well frozen out politically in the main arena. The two most militarily powerful states in the area, Israel and Egypt, are fairly solidly in the camp of the United States, so that any attempt to use proxies from other local states which might fall under their influence would be doomed to failure. The oil emirates and Saudi Arabia have so much money invested in the West that they're not about to turn against concerns where they sit on the board of directors. Iran is open to Soviet military absorption, but this would be considered beyond the tolerable rules of the game by the United States and would provoke a face-to-face conflict which neither could afford.

No doubt the Soviets will do what they have always done and back insurgent forces wherever they exist in the area. But they cannot afford to go too far. The dominant insurgent force that seems to be emerging in the Middle East is xenophobic fundamentalist Islamic nationalism, and since the Soviet Union has a large Shiite minority where it borders on the Middle East, it could find itself fomenting a jihad that could spread to the USSR itself. The fact that the Soviet Union is now attempting to put down a nationalist Shiite rebellion in its satrapy of Afghanistan will not exactly endear it to Imams and Ayatollahs.

The Soviets will probably continue their efforts to encircle the Middle Eastern honeypot around the periphery, in Afghanistan, the Horn of Africa, Yemen, and so forth. If they can set up a strategic situation where the oil from the Middle East continues to flow to the West and Japan only with the approval of the

Soviet Union, it will be very difficult indeed to avoid giving them a piece of the pie. No crass saber-rattling would be necessary.

Nor will any saber-rattling by the Soviet Union be very credible in the 1980s. For in the 1980s, the Soviet Union will not be able to afford pushing the United States too far. Soviet dependence on American grain will not evaporate. If they annoy us too much, they might not starve, but they'd have some hungry times. And if *really* antagonized, the United States will be in a position to fulfill the worst Soviet nightmare without firing a shot.

If an agreement on mutual face-saving can be agreed upon between the United States and China on the last remaining significant issue between them, the ultimate destiny of Taiwan, the United States could redeploy much of its powerful Far East naval force to the Middle East and tilt the balance well against the Soviet Union, assuring control of the vital oil channels by sea power, whatever the political situation in the on-shore territory. To make the Chinese cooperative, the United States could help build the Chinese a mighty modern military force to take up the vacuum facing the Soviet Union with American forces withdrawn to the Middle East. The Chinese could pay for this by allowing co-development of their considerable oil reserves. A trade that would definitely help both ballclubs.

This is the big stick that the United States will carry in the 1980s whether it realizes it or not. The only thing that the Russians would fear worse would be nuclear war. Indeed, once China had ICBMs trained on the Soviet Union, the Russians might feel that a pre-emptive nuclear strike was their only option.

So if they will risk nuclear war to prevent such a ghastly situation, what won't they do *short* of war? One thing they certainly can't afford to do is make the

United States feel vitally threatened by any action of theirs. Certainly this excludes interfering with Middle East oil supplies.

Of course the oil supplies of the West cannot be safeguarded by the Soviet Union's acquiescence. In the 1980s, OPEC will continue to be an independent political force, and the OPEC powers will continue to gobble up an ever-increasing proportion of the world's GNP. With a whiphand over the heart of the world's dwindling oil supply, OPEC will slowly cut production down to stretch out their long golden afternoon of wealth and power and continue to raise prices at whim.

Up to a point.

No one can say exactly when that point will be reached, but it will arrive long before the 1980s are over. The point when the western economies really start to unravel under the dual pressure of energy shortages and OPEC-generated inflation. When it really hurts. When tens of millions are unemployed and the living standard is visibly shrinking year by year in the developed world. When millions are starving to death in the third world for lack of fertilizer and developing nations are sinking back into pre-industrial poverty.

Will the most powerful consortium of nations on the face of the Earth—the United States, Western Europe, and Japan—adhere to non-militaristic sweetness and light while they all fall apart economically, or will at least some of them put aside non-interventionist idealism in the face of the need to survive and go in and get the oil they need by main force at cutrate prices when push really comes to shove?

Would a mother steal milk to feed her babies?

The only thing preventing such a straightforward imperialist solution would be that paragon of anti-imperialist zeal, the Union of Soviet Socialist Repub-

lics. Would the Russians put OPEC under their nuclear umbrella and become the saviors of the most bloated plutocrats of all? They might, if they thought they could get away with it. The West might not be willing to risk nuclear war to grab the oil.

But if the Russians pulled this one, the food they buy could get awfully expensive. China could begin sprouting thermonuclear teeth. The United States would grow quite cross with the Soviet Union. Not cross enough to risk war, but certainly pissed off enough to no longer be Mr. Nice Guy.

Besides, if fear of nuclear war would prevent the West from taking over the Middle East oilfields, the United States would surely reciprocate by deterring any Russian hegemony over the area. The result would be an OPEC still in the catbird seat.

And by the middle of the 1980s, they'll probably be gouging the Soviet Union too.

The situation will be intolerable to the two most powerful nations on Earth, not to mention the rest of the developed world, and most of the undeveloped world as well.

Would it be so surprising if they got together and agreed not to tolerate it?

What the United States experienced in the 1970s and what the Soviet Union will go through in the 1980s are not discrete internal problems, but parts of a great world-wide transformation crisis. American national policy has reached a morass, and the firm ground at the end of it is not in sight. Soviet national policy will produce in the 1980s a similar confrontation with limits to national policy, a similiar energy problem, and an even worse international mess. Before the 1980s are more than midway over, it will be obvious enough that the policies pursued for three decades by the two superpowers have led to mutual failure.

Perhaps before the 1980s are over, it will be obvious that what has failed is not so much the national policies of the United States and the Soviet Union, but the very concept of national policy itself.

Quite conventional national policy requirements in pre-1945 terms led the Soviet Union to establish political and economic hegemony over Eastern Europe; realpolitik realities and Communist ideology were in happy agreement. So too America's ideological role as the defender of freedom and the foe of Soviet expansionism wherever it raised its godless atheistic head served admirably as a philosophical base for economic policies that made the United States the dominant economic force on the globe, enriching its friends and allies in the process.

As long as these conditions prevailed, it might not be stretching things too far to say that the Cold War successfully served the interests of both the Soviet Union and the United States. It was a stable world order that worked. The parameters were known by both sides and conflicts between them were fought, when they were fought at all, within safe limits. And one must admit that both sides enjoyed relative prosperity during this period, each according to its own internal possibilities. Science and technology proceeded by leaps and bounds; in this area one might almost say the competition was healthy, more serious sport than war.

But long about the middle of the 1960s, this cozy world of good versus evil, the blues against the reds, began to fall apart as the planet as a whole passed into the period of mature transformation crisis.

The transformation crisis began in 1945 at Hiroshima. Prior to that time, disputes between nations could ultimately be decided by superior force. Such outcomes would not necessarily be just, but at least they would be *outcomes*. A system of nation states could function because the battlefield provided a court of final verdict. So national interests

could be pursued and ideologies promoted along with empire, and every game of chess could be played to some stable conclusion one way or another.

But the advent of nuclear weapons changed all that. When the ultimate superior force is one which will destroy all the players if anyone uses it, it cannot be used to decide any dispute short of Armageddon. Which means there is no bottom line anymore and the rules of the national state game as currently played no longer make sense or provide order.

Because ultimately, nation states, as they presently see themselves, exist primarily to play the nation-state game. The rock bottom primeval *raison d'être* for the existence of national governments in the first place is to protect the tribe's territory from the governments of other tribes. Territoriality was not invented by man, most vertebrates exhibit the same behavior.

But most vertebrates do not possess vast arsenals of nuclear weapons. Man, alone among the species, *can no longer decide questions of territory*, geographic or psychic, by all-out barroom brawl.

So all the vast colonial empires broke up and over a hundred new nations were created in a burst of liberated tribal nationalisms. The units of world economic order became smaller and more varied and all too many of them proved independently non-viable.

The viable units—North America, Europe, the Soviet Union, Japan, and Australia—formed into two hostile camps, the so-called "First" and "Second Worlds." These "Developed" northern hemisphere nations had economies based on expanding production, high-level technology, and cutting-edge science. Which gave them economic and military superiority over the "Third World," that is to say, everyone else.

Third world nations maintained political independence—when they could—by playing East against West, and throwing the two camps into the



role of suitor for their political favors. Politically, the Cold War world order served them too. The mutual deterrence of the first two worlds open the space for their independence.

Economically, there were a few Third World success stories, usually when a country that had something to sell to the developed world spent its money wisely or when one with nothing to sell but labor cut a deal for western technology, but overall, the Third World remained in an earlier time zone.

Meanwhile, the Developed World began to see handwriting on the wall as growth began pushing the limits of world resources. It hit the West in the 1960s and 1970s, brought forward by Viet Nam and the throw of the dice, and the Soviet Union won't be feeling it full bore until the 1980s. Developed national economies rely on continued growth, and when they run up against world resource limits, as they must sooner or later, when the pie is no longer big enough for everyone to eat their fill, then we have what the Soviets can at the moment smugly call the "Crisis of Capitalism."

The game breaks down. OPEC comes into being. The cheap energy on which the dynamism of western economies was built is now a dwindling supply of ever-more-expensive goods whose price is set at will by a cartel practicing pre-Adam Smith mercantilism. OPEC is not a capitalist phenomenon; it harkens back to the middle Renaissance, when economics was an overt instrument of national power and vice versa.

Now OPEC is beginning to find that the game doesn't work too well for them either. OPEC can soak the West at will, but what can they do with the money? Only investment in the high-energy western economies can absorb it. Every time they raise their prices, they cause inflation in the West, which decreases the value of investment there, so they raise

prices again, which . . .

The solution is to keep cutting production while raising prices, thus in effect investing the excess income in their own oil, further destabilizing western economies until the breaking point is reached and only the Soviet Union's nuclear umbrella can save them from a desperate imperialist solution on the part of the West.

But in the 1980s, the game will be breaking down for the Soviet Union as well as the West. Their Eastern European empire will be an economic drain while seeming to remain a political necessity, and they will be relying to a growing extent on imported oil too. They can no longer afford to oppose the United States as an automatic reflex action because they must have American food and because America could ruin them by building up China at no little profit to itself. Their straining economy will no longer be able to support a growing military establishment already spread thin, and they'll be running into manpower shortages.

The "Crisis of Capitalism" will be revealed as a "Crisis in high technology civilization" and the Soviet Union will be in the same boat with the rest of the Developed World.

So when the break point is reached in the Middle East and the West is forced into an act of amoral self-preservation, the then leaders of the Soviet Union will be faced with an historic decision.

They can place OPEC under their nuclear protection at minor risk of nuclear war, but at the certain cost of a squeeze on their food supplies and a Sino-American alliance, and maybe cop the oil if they can bluff down the West. More likely, this would result in a mutual deterrence which would do nothing to improve the world oil situation.

Or they could cut a deal.

Certainly it would be tempting. In return for a

negotiated share of the pie for Russia, the Soviet Union and the West combined could control the price of oil to themselves. By military power if need be, but probably by the mere unstated threat of same. OPEC would have to keep its prices down to a level which would make their oil cheap enough to deter the cost of joint Western-Soviet seizure. A shot need not be fired.

On one level, this is naked great power imperialism of the crassest sort. But on another, it could be the opening act of a brand new game. If the West and the Soviet Union are forced by reality to dismantle the nation-state competition game in this most vital aspect, how far might the process go?

The energy crisis is a transnational crisis, and a West-Soviet deal to solve its short-term manifestation in the Middle East by transnational action would be a forced admission from both parties that transnational problems must have transnational solutions.

If China can be brought into the game by its American and Japanese connections, we will then have a situation in which for the first time in human history all the Developed Nations of the Earth and the overwhelming preponderance of economic strength, military power, and cutting-edge science and technology will be playing a transnational game.

Once the ice is broken, deal after deal can be cut, dismantling losing propositions that exist only to serve the national interests of the previous stage of evolution, and consolidating a system based on obvious mutual self-interests.

In this context, it would be an enormous relief for the Soviet Union to let go of its Eastern European empire. As the economies of the total Developed World converge of necessity, common interests will be enough to make war in central Europe incredible, and sooner or later the Soviet Union will no longer feel it needs the Warsaw Pact as the West will no longer feel it needs NATO. As soon as these fears no

longer need mutual deterring, it will be easy enough to negotiate a mutual dismantling of the vast forces facing each other. The conclusions of Marxist economic determinism and capitalist balance sheets will coincide.

Will this be the millennium? Not exactly. The world order that will emerge in the early 1990s will find the globe divided once more into two camps—those that have, and those that have not. In the Northern hemisphere, a kind of transnational consortium of the Developed Nations, an emerging 21st Century transnational world order, with the reigns of world power firmly in its hands. In the Southern hemisphere, a Third World of states prospering off raw material sales to the City on the Hill or let in on a piece of the action, and a Fourth World, the most populous of all, consisting of pauper states scrabbling at the edge of existence with little to sell and less hope.

Unless a transnational Developed World commits itself to bringing all nations, rich and poor, into the club. While the West has long practiced foreign aid and the Soviet Union has long preached the solidarity of the international working class, human history gives little cause to expect that such a massive transfer of wealth from the rich to the poor will ever be undertaken out of altruism alone. Moreover, in the realpolitik world, both western foreign aid and Soviet "internationalism" were counters in the old East-West game that will be defunct in the 1990s.

Further, it will be argued that total world resources simply cannot support a totally Developed world order. Indeed by 1990 it will have long since become obvious that even the Developed World will not be able to maintain even mid-20th Century living standards long into the 21st Century.

Oil supplies will be running dry, at that point even coal reserves will not seem unlimited, uranium ore

will be an extremely expensive item, and, in fact, the Developed World may come to see in the Third and Fourth Worlds the sad face of its own de-energized future.

And therein, paradoxically, lies the hope of the world as a whole.

Throughout the Cold War period, the United States and the Soviet Union waged a fierce struggle for scientific and technological supremacy. Like a good hot pennant race, it produced more than wins and losses, it generated some great performances. From America came the microprocessor revolution, computer technology, advanced genetics. From the Soviet Union came medical advances, leading-edge fusion research, marvels of engineering.

And from both in equal measure came the force-fed Space Race. The Soviet Union developed the first boosters powerful enough to put first machines and then men into space. The United States responded with a space program of dazzling complexity and electronic sophistication which culminated in Project Apollo. At this writing, the Soviet Union has quietly taken over with the first true space station. The Space Shuttle will soon become the latest American response, followed by who knows what on the part of the Soviet Union.

The end of the East-West geopolitical game will not necessarily quench these competitive fires. A transnational world order is not an international world order in which national prides and competitive spirits disappear. The progressive decline in military budgets will release vast amounts of capital for constructive purposes; moreover, to maintain an acceptable level of unemployment, both America and the Soviet Union *will have to* divert much of this savings into other high-technology areas.

What might not be accomplished if the rules of technological and scientific competition became

transnational? When leading-edge research is no longer directed towards military ends, secrecy becomes ridiculous and total pooling of information becomes plain good business. And when survival is at stake, so do cooperative ventures when the scale demands it.

What might a joint Soviet-American space program accomplish? American Shuttles and Soviet space-station technology. The visionary stuff on the NASA drawing boards and huge Russian boosters and automated "freight rockets." From a national point of view, things like O'Neil colonies, a world solar power satellite network, and asteroid mining become half as expensive.

If the world is to successfully pass through its transformation crisis, cheap, abundant energy and open-ended raw material sources must be returned as parameters of a world economy. Fusion, solar power from space, and the eventual mining of the asteroids seem the only viable long-term solutions. Only with these capabilities can the Developed World continue to remain Developed and only with cheap power and abundant raw materials can the species afford a Developed standard of living for all.

As things stand now, Americans generally seem to assume that the total responsibility for creating this 21st Century survival technology rests on our uncertain shoulders. Perhaps Russians feel the same way. For over three decades, the two greatest economic and technological powers on Earth have each seen the other as their only credible rival for leadership of the human future. Soviet strength was perceived as American weakness and vice versa.

What a relief, what a vast spur to confidence and progress, might it not be for the two most technologically advanced nations on Earth to each see the other as its mightiest ally against the fall of night?

—Norman Spinrad

# BELLEROPHON

KEVIN CHRISTENSEN

**IT HAS BEEN ALLEGED THAT  
FANTASY AND SCIENCE FICTION  
ARE ONE AND THE SAME. NOT SO;  
SCIENCE FICTION ADDRESSES THE  
POTENTIALLY REAL. EXAMPLES:  
CHIMERA, PEGASUS, AND  
BELLEROPHON**

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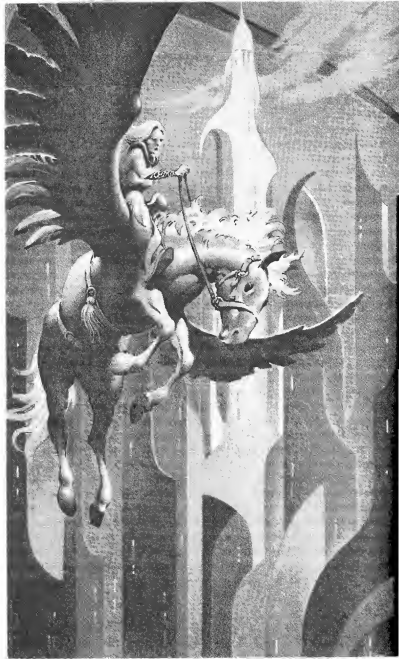
Saturation point arrived with the new Earth Inter-corp ambassador. He smiled, clasped my hand and said, "Natalie Schofield? You were there when he fell."

He hadn't garbled the words through an hors d'oeuvre, or slurred them across a cocktail glass; unlike some others among the various diplomats, city VIPs, socialites, party-up-and-comers, and even waiters who had offered up the same words earlier this evening, and on a myriad similar occasions. But damn. Like it had been a privilege.

"Representative Schofield to you." I held my hand straight as a cold mackerel in his grip. "No matter where I was." His hand dropped away in the sudden local silence, the smile gave way to embarrassment. "Excuse me." I turned away and began to thread my way through the host of mingling notables assembled in the open plaza.

"Natalie." I recognized Lyle Sarr's voice and felt his hand on my shoulder. I pulled from his grasp with





a shrug. "At least tell me what's wrong." I stopped to let him catch up. He is a portly little man, and has been with me since my first campaign, so I owed it to him not to make him chase me.

"The usual," I said simply.

He wrinkled his forehead, and nibbled his lip.

"And don't apologize for me."

"Okay," he sighed. He glanced overhead. "Bridling Peggy?"

"Yeah."

"Nice night for it." He blends sympathy and sarcasm without real understanding. But he needs me, so we let it go at that. He went back to the reception. I went and got Peggy from the stables and led her to the elevators beneath the flight landing.

My mood is generally rotten to begin with, but with Peggy along the ascent gets really claustrophobic. Her big feathered wings seem to overwhelm the compartment. And she's always shifting her hooves about, making great clop-clop noises, and neighing at odd intervals. Besides all that, the sensation of weight leaving as we get closer to the axis makes me nauseous. Then the door opens. Catharsis begins with the view.

Below me a panel of landscape thirty kilometers long stretches off to the opposite end of the cylinder. Overhead and from the sides two other land panels and the three alternating glass sections reach off, converging in a parasol horizon. Mirrorshift is nearly complete. Clouds form a wispy tunnel where nocturnal flyers soar and glide.

Here the centrifugal effect is lessened enough for Peggy's wings to become more than cumbersome ornaments, to become, in fact, wings. We move forward gingerly, down near the edge. I tangle my fingers in her mane, and pull myself to her back. A few more steps, then she leaps and adds the power of her wings, taking us nearer the axis where flight is nearly

effortless.

Consider the sight and the setting: A winged horse in the sky of an inside-out world. A moment's pause, and Virgil Sayer must come to mind, the assumed he of a thousand conversations.

I think I come up here less to get away from his name, more to remember who he was, apart from myth and folklore. (You know how it goes: Take one part amiable rogue. Place in the casino aboard the Hohmann Queen. Add remarkable success. Allow enemies to gravitate. Spice with a few folk motifs. Garnish with a few genetic creations from the dark-ride zoo. Serve up with a tragic romance. Voila. C'est un crap.)

Virgil, when not encouraging misconceptions, merely allowed them.

I met him back on the Hohmann Queen, due to a lapse of judgment on my part.

A friend named Iyako pointed Sayer out on my first visit to the Hohmann Queen's notorious casino.

"He's the one with the female entourage," she said. "Why the sudden interest?"

"Cohabing with Dirk turned out to be a mistake," I replied. My ex had neglected to mention a passion for gambling surpassing his passion for me. He managed to put me in debt for an extra hour of intransit labor per day, as well as losing me my guitar. Iyako kept I-told-you-so down to a passing glimmer in her eyes.

Sitting with four other players on the gaming floor a meter below us, Virgil Sayer was dressed in a black frock coat, frilled shirt and vest. His dusty brown hair covered his ears, and was parted to reveal a wide forehead over clear gray eyes. He wore a jawline beard, was tall and possessed an athletic build. He gave an impression of easy confidence.

"Ten years he's been doing this?" I asked, and Iyako nodded. "Where did he come from?"

"No one knows for sure," she replied. Iyako is a little gem of atypical beauty: deep vertical dimples under fine cheekbones, and a cascade of black hair among other attributes. "Sayer has your guitar?"

I shook my head. "A man who can be found playing with him." After breaking Dirk's nose, I'd briefly inquired as to the distribution of my Fleta. "An Emory Titus."

"Titus is the balding man across from Sayer."

I couldn't see Titus' face. He looked shorter and stockier than Sayer, and not so popular with the groupies. I noticed then that a few of the players used hand computers.

"Rumor has it that Titus has been hired to get Sayer off the Queen," Iyako continued.

"Oh? What powers object to clever charlatans?"

"Who else but dull authority types?" As we watched the game, Iyako described a few. Eve Brooks, a Providence Representative, epitomized the Offense to Tradition movement. Her efforts turned up in the form of plaques honoring pioneering colonists and builders; an attempt to fight Sayer's romantization, and some anti-gambling legislation. Jerome Hawthorne represented the Damaged Pride movement. He headed Truesight Prosthetics R&D at Providence. Truesight is a large firm claiming total prosthetic capability. Sayer had taken a lot of money from Titus. Rumor connected Titus with some of the more unsavory attempts to bring down Sayer.

Sayer's continuing success in the face of such opposition enhanced his notoriety all the more. I'd first heard of him on the last trip, when he'd been accused of raping an Intercorp ambassador's daughter. Despite polygraph and VSA supported testimony from the victim, and supporting testimony from the girl's personal doctor and bodyguard who found Sayer drunk and unconscious with scratches on his face, and a heat picture of the area showing no trace of

anyone other than the principals in the area, Sayer was released with apologies from Ambassador Widdengren and his daughter. No details were released. Speculation was rampant. Sayer continued on, troubles or no.

A murmur from the table below interrupted our conversation. I looked down to see Sayer make a slight gesture of acquiescence, and Titus gathering in a stack of chips. Sayer rose to leave, saying something to his retinue which left a few of them with pouty expressions.

"His troubles appear to be continuing," I commented. Iyoko frowned after Sayer. The game below began to break up. "I guess this is my best chance to negotiate with Titus."

"I wish you luck," Iyako said. "He's a story in himself. A cyborg."

She smiled and retreated before I could frame another question. So I strode down to the gaming floor and walked up to Emory Titus.

His face startled me at first. It was completely immobile, void of any expression, with a slight caricature effect in the definition of his features; the distinct lines at the corners of his eyes and across his brow, the sudden black of his eyebrows and mustache, and the abrupt baldness. After a brief hesitation I spoke.

"Emory Titus?" He gazed at me from behind his blank face like a machine waiting for more data. I complied. "It's about one of your recent gambling companions, a Dirk Jaussen. He lost something precious to me in a game with you; I want to buy it back." I recognized his left eye as prosthetic by the aperture—like a camera's rather than an iris. He spoke in a flat dispassionate voice.

"You're Jaussen's cohab."

"No longer."

"A little late, but a wise move. He's a fool." Titus scrutinized me further. I felt like a butterfly pinned to a board. "What was the item?"

"A Spanish guitar."

"I don't have it."

"I was told you did."

"Jaussen didn't explain properly, I'm sure. One moment, I think I can help you." He made a gesture with his left hand. His features relaxed and flowed with expression. Then he screwed up his features and massaged his face with both hands. "It's easier to talk when I turn off the poker-face," he explained, his voice now carrying a degree of humor. He turned and swept his winnings into a purse. "Come with me, and we can see if no one has taken your instrument from the Shambles."

I fell into step beside him. "Let me guess. There's a hock shop."

"Very nearly I suppose. People can exchange credit, or pledge work or exchange goods for chips."

"I haven't seen many leisure goods up here."

"They accumulate a bit each trip," he said. "People pawn things they've brought along. The ship imports a few things to put up for sale in the markets, to go along with the food and handcrafts. Some colony items are displayed or advertised here. Real estate. Occasional zoo excess. Enough to spend a pleasant afternoon browsing, if that's your inclination."

We passed through the gardens and entered the quaint crooked streets of the Shambles.

On impulse I asked, "What do you do?"

"I'm involved with decision-theory. Teaching computers to work with incomplete information. How to guess skillfully."

"I thought you might be a professional gambler."

"Like Sayer? No," he laughed. "PanSol won't allow that to happen again. With me it's a serious hobby related to my work." He led the way into a little shop.

"I'll just be a moment." He stood in a short line at the counter.

There were no goods in this shop to look at, so I waited near the window. Across the narrow way little knick-knacks, the latest beta-cloth fashions, and various gastronomic articles filled most of the shop windows. The shop directly across the way had an eye-catching difference: it showed holo images of a unicorn and a griffin. Providence zoo excess. Titus interrupted my observations.

"Your instrument has been sold."

"Who to?"

His real eye seemed to twinkle.

"Virgil Sayer. I thought he might have gotten it. He's an easy mark for that kind of thing."

I felt my depressed and bewildered look come on.

"I think you can forget about buying it," he continued. "Sayer doesn't need the money just yet."

"What does he need?"

"I can tell you where to find him." He paused and ran his eyes over me. "You may be able to come up with something."

Titus' directions had me waiting outside a gymnasium just the other side of the spoke. Though the day had worn on me enough that I doubted all the hassle was worth it, when Sayer finally strode out, heading for the elevators, I went after him and expressed my wish to talk.

"You caught me at a bad time," he said. "Later, maybe."

Something in his manner brought back a memory of pouty faces. A few clouds of ill-will drifted over the fuse that ran to my temper. I tried to suppress an outbreak. Nearby, an elevator door hissed open.

"It's very important."

He turned a lazy glance my way and ambled through the door. "Aren't you one of Emory's little

jokes?" he said.

I flared. "Aren't you being phased out by a machine? I came to gloat."

He sat and strapped in. "I've got plenty of time to handle Emory." He spoke with the defiance a man might use as the edge of his confidence has begun to wear away. Then he smiled and returned to a condescending tone. "Floor please."

I glanced over the long row of buttons, then back to him. I ran my hand over them all. He glared at me as the door closed, cutting off the meeting. I felt anger at losing my chance for negotiation, further vexation at Dirk, and outrage at Titus. He appeared to have used me easily for some petty prank.

"Twenty-seven and still gullible," I muttered. Then I went home.

The designers of the Hohmann Queen had gone to great lengths to avoid the mind-numbing effects of standardization, extending great variety to every part of the ship. The basic housing however, seemed impervious to their efforts. No matter how they arranged the bed, closet, drawers, no kitchen and no bath, it always looked or felt the same. When I got home I threw my stuff all over the room, attempting to break the outlines. All the disarray left a guitar shaped hole. In an effort to relax, I stepped out on the balcony (labeled patio) to take in the scenery.

Living in the Hohmann Queen is like living in a big doughnut. Overhead the sky is a glass mosaic. Beyond the glass is a view of the central hub, and the stars made gypsy by our rotation. Inside, closer around me, cluster various types of housing, especially dense here near the base of a spoke.

The apartments are stacked in piles, or terraced in irregular rows. Sometimes drawn beta-cloth curtains glow with internal illumination. A family of four plays on a grass patio, unaware of a couple mak-



ing love in the apartment beneath them. There are no streets, only paths. Cypress trees grow abundantly, and are reaching ages where they begin to be interesting. Not surprisingly, it failed to soothe.

Iyako met me after work the next day.

"How did things go yesterday?"

"Lousy."

"How lousy?"

I told her. Just as I finished, lamenting how I'd never see my guitar again, I led the way into my apartment. My guitar rested in the middle of the floor.

"How lousy?" she said.

On the case I found a delivery slip and a note from my landlord. And a change of ownership affidavit signed by Sayer.

"I thought you said he legally owned it."

"He did." I opened the case, took it out and played a scale. "I didn't even tell him I wanted it."

"No charge?" she asked. "No strings?"

"New strings. I suppose I ought to be grateful. But I didn't even tell him who I was."

"Titus knew."

"So Titus told him. Why would he give it back?"

"At least you've got it."

"I guess I shouldn't worry about it."

I played a few bars of Dowland and fumbled.

"I would if I were you," Iyako said.

"I am."

"You said you weren't going to."

"Sayer is supposedly a drone, an athletic hedonist, a drunken rapist, and capable of manipulating Pan-Sol and Intercorp justice. He gives a stranger who insulted him something he paid five figures for absolutely free, and I'm not supposed to wonder why?"

"How are you going to find out?"

"Ask him."

"He didn't seem very easy to talk to."

"Yeah." I fell silent. "Maybe I'll just forget about it."

Maybe not. Two days later I found where he lived and sat on his front steps with my guitar. If I'd cared to look, and if there were enough light, I could have watched him coming from far off. (By Hohmann Queen standards.) Living quarters were spread thin here. An open stream flowed by, winding among adolescent pines and aspens. Here more than anywhere else on the Queen, I felt tranquil spaciousness. So, involved as I was in playing, I didn't notice him approach. He applauded as I finished a piece.

"Very nice," he said. I looked to see him standing a few meters away.

"Thank you." I put my instrument in the case, and set it by my feet. He wore a frock coat similar to the last I'd seen him in.

"You are Natalie Schofield."

"My Indian name is Sitting-on-Stairs."

He smiled and stepped closer.

"I appreciate the gift," I continued.

"I apologize for being rude," he replied.

"And I shouldn't have made that remark about you being phased out."

"Your provocation is understandable." He shrugged. "How did you come across a Fleta, by the way."

"A friend of a friend died."

He nodded.

"I was going to offer to buy it back," I said.

"Emory told me the circumstances."

"Can you afford this?"

"Time will tell," he replied. "I expect so. Good P.R."

"The way I heard it, you weren't the one to win it anyway. It was Titus."

"I've taken Dirk for quite a lot." His tone held regret, not for Dirk, but for our relationship.

"You weren't responsible."

He shrugged again, and fingered his beard gently with one hand. "I am sorry though."

Then he moved forward as if to pass me and enter his lodging. I held my place on the stair.

"Wait," I said. "What are Emory's jokes?"

"Emory likes to create a negative environment for his opponents, to take their mind off the game. He sends people to me, telling them they are wanted."

I flushed, remembering. I hoped it was dark enough that Virgil didn't notice.

"I hope you beat him," I said.

"I've got time."

"But you are worried."

"Don't you worry."

"Why not?"

He hesitated a short moment. He glanced around, thought a short time more, then said. "Come in and I'll show you."

I gathered up my guitar, and let him pass in front of me to palm open the door lock. I entered after him. I had imagined more luxury, or at least less austerity. The main features of the room were a visiterminal and a bean-bag chair. Three other doors led off the front room. One to a small kitchen. One to a bedroom in which I saw a conspicuously ordinary bed. The other door was closed. A sliding glass panel opened to a patio under the bedroom window. Virgil went up to the terminal and called up a program called cyborg.

"I don't lose that much to Titus, except in attempts to buy information. The biggest problem is that his winnings cut into what is available for me."

The screen showed an elaborate series of graphs charting betting patterns and winnings of the various players. Virgil explained that Titus had a computer instead of a left lung. Aside from doing the sensory

moderation for his prosthetic eye it played the game for him. He input in various ways, and output into the vision field of his left eye. Virgil described his method of figuring the program an opponent ran; mixing the various decision variables—straight odds, risk-profit, betting history and so on—and claimed he could deceive a program once he knew it.

"I think your mind is constipated," I said.

Virgil scowled at me.

"I assume you've played computers before and won. Has it ever taken this long? I think he cheats."

"I can tell when people cheat."

"Do you cheat?"

"No."

"How come you win so much?"

"I'm very talented."

"Maybe Titus is more talented."

"I can't be read."

"What about him and his pokerface?"

"I don't see what any of this has to do with you."

"I don't like Titus. And I owe you. And right now you remind me of Dirk. So sure you're okay and everything falling apart."

He stared into the terminal for a moment. He canceled the program, and walked into the kitchen. He reappeared with something strawberry and frothy which he handed to me. Then he stepped inside the room I hadn't seen and closed the door behind him.

I sat in the chair and sipped the drink. After ten minutes, he hadn't come out, so I went over and knocked on the door.

"Yes," he said from behind me. I spun around. The v.t. screen showed a view of him, apparently in the next room, his back to me.

"What are you doing?" I asked.

"Relaxing," he replied. "I thought you left."

He worked over a table which held some stop-motion figures, two of which intimately concerned

him, both thirty centimeters tall. One at first glance looked like an upright bear; the other like a man-shaped figure in dark armor. A hemisphere-front projection screen spread around the rear of the table. He moved each creature slightly, so slightly that I was only intuitively aware that each limb, joint, and facial feature had been shifted. He stepped back. I saw a flash and heard a distinct shutter click. Then he moved forward and began again.

"You aren't a very good host," I said.

"I don't get much practice."

I assumed he was doing a darkride film. Darkride parks are everywhere. They reproduce fantasy or inaccessible experiences in such a manner that the brain perceives them as real. They evolved from amusement parks and movies. A man named Trumball got to asking what would happen if he projected films at faster than the standard twenty-four frames per second. He found that at seventy frames per second, the mind could not perceive between frames at even subconscious levels, and is five times as convinced of the reality. Contemporary rides blend film sound, holography, physical design, and mechanical props to achieve their effect.

As I watched Virgil manipulating the kinetic sculptures, it occurred to me how he could win so much at a game like poker.

"Curiouser and curiouser," I said.

Virgil chuckled. Still he didn't turn. His fingers touched the face of the bear-thing.

"What happens if you don't beat Titus," I asked.

"A couple of things. If I can't pay my fare, I get dumped off at Providence. He's eating into my working capital. Between him and expenses, I'm way behind."

"Could you get work at Providence?"

"Sure." He paused briefly to consider his handiwork. "Eve'd love to have me doing something re-



spectable."

"At the darkride park?"

"No. What exotics and rides are done at Providence use genetic engineering, emphasis on engineering. They don't have nearly the control over the finished product, and they don't have much use for them when they're done."

I remembered the zoo excess I'd seen up for sale in the Shambles.

"I saw where they've got a couple up for sale."

"Killing an exotic is a status thing in certain circles," Virgil commented. "I expect it will continue." He turned his attention back to the armored figure.

"Then what would you do?"

"Something basic. Chasing rock, or picking up cargo." He sighed. "Maybe I am in a rut, though I can't see it," he said, mostly to himself. "If you get any ideas, I'll be glad to listen."

"How long are you going to be in there?"

"Till Zapranoth gets this close to Draffut."

That, I could see, would take a while, and I did have to get up in the morning. I turned off the v.t. and went to sleep.

"What are you doing here?" I pried open an eye and saw Virgil silhouetted in his bedroom doorway.

"What time is it?" I yawned.

"Four," he said, and muttered, "I can't believe it."

"A couple more hours then." I rolled over and waited.

"I believe I asked a question."

I turned back over. Virgil had turned out the light behind him, so I could now make out his features.

"I don't like being put off," I said. "Besides, I figured out what your problem is . . ."

"What problem?"

". . . and I thought you'd like to know. He's reading you."

Virgil shook his head and moved out of the room. I heard the glass door slide open and closed. I sat up and slid open the window by the bed. He was making himself comfortable on the grass-covered patio.

"From what you've said, it's the only option you haven't considered. That's why you haven't figured it out."

Virgil seemed to be having trouble getting comfortable.

"You read body language like a book, don't you," I said.

"Better."

"Why can't Titus do the same thing?"

"Because I project as well as read."

"Oh." I hadn't thought of that.

"So there's nothing for him to read except what I want him to see. And even if he isn't trying, it works on the subconscious."

"On Titus?"

"Not consistently."

That reassured me that I had the right track. So I persisted.

"Well, he's reading you somehow."

"How?"

"I don't know."

"Good night then." He rolled over. I rested my chin on my arms and watched him for a few minutes and thought. Looking out over the patio, I could make out the other quarters. The closest was just the other side of a pond, through some trees. The sight distracted me from this problem, reminding me of something else I had wondered about.

"Virgil?"

"What?" Reluctantly.

"I can't sleep."

"I can."

"What if somebody came in and raped me?"

"Wouldn't be me."



"No?"

"Call it the way I was raised if you're offended."

"I heard that you attacked a girl right over there."

"The court said otherwise."

"How did you get off?"

"I was innocent."

"It didn't sound that way to me."

"You didn't hear my version."

"I love stories."

I heard him sigh. Then he sat up cross-legged and looked toward me. He sat still for a moment, fingering his beard.

"How did you hear it?" he asked.

I told him what Iyako had reported. He interrupted at times, pointing out locations; where the Widen-gren people had been lodging, where Melinda had been walking, his own route home along the stream, where the attack had been reported, her escape and discovery by the doctor, and his own discovery by the doctor and body guard.

"Well?" I said.

"You know enough." He'd taken the offensive. "Figure out what happened, and I might decide you could be of some use."

I drew a blank. He gazed at me and shrugged. "I thought not," he said. Then he turned and slept. A thoughtful hour later I left for work.

Virgil had chosen a poor method of getting rid of someone with little else to think about. I followed Virgil discreetly for a couple of days, and observed that he didn't drink, neither did he dally with the groupies; I decided he had been set up. Max Widen-gren's daughter had a personal doctor. When I in-quired as to why I found the basis for a theory.

Melinda Widengren was a cyborg. A serious acci-dent had left her paralyzed and deaf. Prosthetic hear-ing devices and spinal fusion, with a moderating

computer installed, restored the losses. The doctor was not only her fiancée, but an employee of Truesight and a relative of Hawthorne.

If Hawthorne was behind it, he would exploit his capabilities. Prosthetic devices translated between neural and electronic signals. A capability to pre-record is implied, as is the ability to interrupt a direct signal and substitute a recorded one. Suppose that when they operated on Melinda, they also wired her vision. A previously staged attack could be recorded and played back into her. For her it would be totally real.

Assuming the technical details then, the perpetrator still requires a knowledge of Sayer's habits, and some control over Melinda's habits. The doctor had both. He could use the stream and his justified presence to deceive the heat picture.

I found Virgil on his way to the casino one day and he verified my theory, though with little enthusiasm.

"And you just asked them to x-ray her and explain the excess hardware?" I asked.

"More or less."

"How come it was hushed up?"

"I wasn't in on the negotiations." He stretched and yawned. "Widengren is a Machiavellian sort."

"The doctor?"

"Word came out that he decided to practice on a penal rock somewhere."

"How does it feel to have enemies like that?"

"You claim to be on my side," Virgil said. "Just think about it."

A few days later, armed with another theory, I located Emory Titus lunching in an open market in the Shambles.

"Hello, Emory," I said cheerfully. "Remember me?"

He glanced up from a bowl of chowder, offered no

sign of recollection or interest, and continued to eat.

"I've spent the night with Virgil since you talked with him again, and have gotten my guitar back. I want to thank you for your part."

The first few words got his attention. His interest grew exponentially as I spoke. He smiled warmly, took me by the arm, and led me out from among the crowded tables to a quiet spot behind the food counters. There he stood directly before me, still holding my arm firmly. Both eyes fixed on me.

"Would you repeat what you just said?"

"What?"

"You said you slept with Virgil."

"Yes."

"Say it again, as you said it before."

"I spent the night with Virgil, and have gotten my guitar back. And I want to thank you for your part."

He grinned broadly, and rocked with breathy laughter. I pulled a little with my arm, but he didn't let go. He paused in his joviality and returned his attention to me.

"And how," he said, "do you intend to thank me?"

"I have thanked you."

"Oh come now."

I pulled again with my arm, then smiled and relaxed.

"I'm in need of a proper thanks," he said with Victorian gusto.

"I could rip your throat out easily."

He began to laugh again, but gazed into my face. Then he let me go.

"Sorry. I hope you will excuse my excesses."

"Good day."

I walked away leaving him with a somber expression. I heard him chuckling before I got far.

Virgil was dressed in his usual outfit, the dark frock coat. He smiled casually on seeing me, but showed no

inordinate enthusiasm.

"I think I know how he does it," I said.

"How?"

"Aren't you even interested?" He hadn't changed his stride at all since I'd caught up with him.

He shrugged, slowed, smiled, and fingered his beard. "I say again, how?"

"I'll tell you over lunch." I felt enthusiasm, but not to the point of being beyond consideration.

"I'm usually at my table now," he said, still striding on.

"You want to throw away more money? How did you do yesterday?"

"I set a record," he replied. "So tell me now, and I'll beat him."

"Not on an empty stomach." I stopped and planted my feet.

Finally, he gave in. We went to a place with heavy gray lunar stone cut and piled around us like medieval walls. A tapestry hung next to our table over one wall. It pictured a lunar mass driver flinging great buckets of ore and stone into orbit. A hearth radiated warmth. As we ate I related my conversation with Titus.

"And?"

"Well, think about it."

He stared at me.

"Titus seemed to think your going to bed with me was a great joke."

"So?"

"Okay, I'll spell it out. He seemed to think it unlikely that you had slept with me. But I'm attractive enough, so he asked again to make sure."

Virgil scowled and continued to eat.

"Then he knew that I was telling the truth, granted he put more into it than was there."

Virgil stopped eating and gave me his full attention.

"What are you getting at?"

"Just listen and think," I said. "You told me you have control enough over your own body language to misrepresent your game to an opponent in such a way that he doesn't know he is being manipulated. A conscious act of deception."

I could see the wheels turning, grinding up against the mental block. He'd taken it for granted that he couldn't be read.

"But the fact that you gave my guitar back is evidence you have an emotional reaction against that sort of thing."

"And Titus can tell if someone is telling the truth or lying." Still skeptical.

"Or at least make a good guess from your emotional state."

"PanSol jams microtremors for VSA's." He was protesting still, but looking for possibilities.

"What do you know about thermography?" I said.

"Just seeing infrared wouldn't do it."

"Not seeing infrared. Seeing a temperature map, using infrared. Emotional changes cause minute temperature changes. With computer enhancement, he sees the differences as colors."

Virgil stopped in thought. The wheels turned, strained, then ran free. "That would work," he said. He looked down again, and finished his meal.

Afterwards, we walked together towards the casino. Virgil paused in the gardens. He strolled over to a bench and sprawled upon it. I sat on the grass in front of him.

"You aren't just going to catch him," I said.

He shook his head. "Right now, Titus is seeing signs of me breaking."

"Sleeping with me."

"Other things too." He fingered his beard. "I could feed on that for a while. In the meantime, with a

bio-feedback unit I could bring it under conscious control."

"If you start winning he'll know that you know."

"I only need to do it once."

"You figure on a big pot."

"I'm sure I can manage that."

"How?"

"First things first." He stood and extended a hand to help me up. "I'll go display my symptoms. I want you to go to the Shambles and price a feedback unit for me." He started away.

"What's in it for me?"

He stopped short, turning with an expression of mixed bafflement, defensiveness, and then contrition.

"Sorry. I'll get it myself. Call it square for the guitar."

"I just don't want you making assumptions about me," I said. "That's what upset me the first time we met."

He nodded and went off to the casino. It occurred to me that I ought to decide how much I liked this man. I resolved to wait for him to make a move on a personal score. Also I would see about performing in the casino. There was a small stage that was usually vacant.

I found I could pay in performing time for the extra labor due from me over Dirk. It gave me a chance to unobtrusively watch Virgil's progress. I didn't see any. The minor players began mimicking Titus' betting behavior towards Virgil and visa versa whenever possible. As time passed pots grew smaller and smaller. Although Virgil didn't lose much, except in obvious attempts to buy information, he didn't win much either.

A couple of months rolled by. I never did tell anyone exactly what had passed between Virgil and me.

I'd nod and smile at whatever they guessed. I had staved off a couple of would be romancers, and was tinkering with the idea of encouraging a couple more when Virgil asked me out to dinner.

He showed up in ordinary dress, perhaps anticipating my ordinary outfit. I didn't want him to think I was trying to impress him. Over a meal of fish and chips, the conversation rolled around to his efforts when he startled me by laughing. I looked around. Not seeing anything, I turned my best inquisitive look at him.

"Just anticipating," he explained.

I stood abruptly and started walking away. He followed quickly.

"Natalie?"

"Your success doesn't seem so inevitable to me."

"The pattern is set. When the time is right, Emory will think I'm bluffing, and he'll call."

"And that will be it?"

"Yes."

"Why?"

"Because Emory hasn't broken me. If I hock my gear, I've got plenty enough to stay on the Queen."

"And he'd cover a massive bet to do that?"

"He wasn't hired to come here," Virgil said. "He paid. He wants to be known as the best. For that, he'll do it."

I stopped walking, and turned to face Virgil. I saw again the easy confidence in his eyes.

"And you, why will you do it?" I asked softly. "To be the best?"

His expression changed to something more thoughtful, more melancholy.

"Mere survival," he said.

"There must be more to it than that."

"Why?"

"Because there are other ways to survive."

"Like what?"

"By growing things, for instance." I made a sweeping gesture with my hand to refer to other things. "You could have just turned him into security."

"All right then, pride," he muttered.

"And how will they try next year?"

"Look, I'd really much rather be living elsewhere, doing something else. I applied for artist-in-residence at the darkride park years ago. They prefer to play games with genetics. So I've been accumulating my own gear."

"So you plan on staying aboard the Queen forever?"

He shrugged. "They'll open up someday. For a little culture. People with non-essential talents."

"I think it's taking longer because of you," I said. "Eve Brooks paints you as a living example of the evils of hedonism."

"It's more complicated than that. Eve is a traditionalist. But she's also a bit tiffed over the public not making much of the way her husband died."

"Sounds like you know her."

"We're acquainted," he said, then continued. "The corporate lobbies consider tradition to be more profitable and stable."

"You could go to other places. Earth."

"I'd prefer not to be anyplace strategic."

The way he said this last sparked a connection between the generalized decade of his tenure on the Queen, and a time of violence on Earth.

"So you're just going to wait it out?"

He nodded. We started walking again, both solemn.

"They'll be shuttling people off to Providence soon," Virgil said. The words hung on the air, draped over unspoken implications.

"You better make your move pretty soon then," I said.

"I suppose so."



We parted a few awkward moments later.

The shuttles began arriving, taking people off the Hohmann Queen to their new homes, jobs, and mortgages at Providence, and would be doing so for several days. Iyako left on the second day. The population decline showed everywhere except in the casino. Interest ran high in the possible outcome of Virgil's duel with Titus. I finagled my way into more performing time. And I noticed a few new faces, people who had come from the city on business, and happened to have time enough to watch the game. Two in particular stood out in mind.

The first was Jerome Hawthorne himself. Of a somewhat bland physical appearance, he managed to come across as striking due to an intense personal drive, and an incredible wardrobe. He sat in on the game, never once looking at his cards. He just antied up and folded, smoked big cigars, and did a couple of other calculatedly obnoxious things to make his presence strongly felt. Virgil ignored him with great skill.

The second I met as I performed. Only a few people sat in proximity to the stage, so I played mostly to myself, sifting my feelings. On a particular occasion when I decided to sing, as a change from purely instrumental work, I was surprised to hear someone singing harmony. I fumbled and looked down to see a woman sitting at a table out of line with the game. She smiled up an encouragement, and I finished. She looked to be thirty-five, and a little taller than I, fuller bodied, but still slim. She wore her hair to shoulder length, tied back simply at the nape of her neck. Her face was comely, the forehead moon-shaped; she had well defined, but rounded cheekbones, and slight lines at her eyes and forehead. She had a graciousness and dignity that did not conceal an inward tiredness—and a conviction that she could do well

despite it. We spoke at the end of the song.

"I'm surprised that anyone would know that song," I said.

"The loveliest things should never be forgotten," she replied. "You sing and play with much expression."

"Thank you." I felt appreciated for the first time since Iyako left.

"We appreciate talent out here," she continued. "What is your name?"

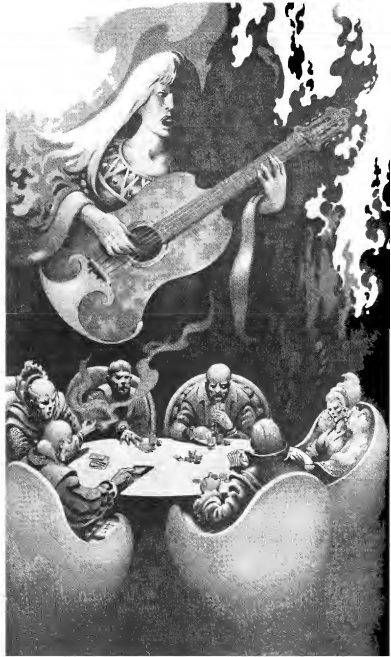
I told her, and volunteered the information that I'd be working the crops.

"And I'm Eve Brooks."

That stunned me, as I'd built up a completely different picture, one far easier to dislike. At that moment, a murmur rose from the tables. We both looked over to the game. Then our eyes met, communicated something, and we moved together across the room to a clear spot on the terrace.

Do you know the game of draw poker? I'll describe an example of the game. You may pick it up from that. The dealer, under the eyes of a PanSol security camera deals five cards face down to each of five players. The first player to the dealer's left, a well dressed man brandishing a foully aromatic cigar, says "fold," and does his best to look arrogant and overpowering. The next player opens the first round of bidding. It is a small bid, a token that says, "I was there." The next man sees the bid with an equal number of chips. His face is rigid, unreadable. His presence ominous. He has won a standoff, but seeks a crown. The next player, a woman, consults her cards and a pocket computer, and also folds.

The last man has a unique aura about him. If you watch him closely as he plays, you find yourself making guesses about the strength of his hand, which invariably prove to be wrong. He ignores the cigarist so skillfully that a nearby person may fall under his



influence and ignore the man too. But of late there is tension in him. All his skills, his place and his legend have been challenged. He is not willing to merely ride out the challenge, perhaps not at the expense of his dreams. He calls.

The first player draws three cards. Titus draws two. Sayer takes one. The first player makes a small bid. Titus raises moderately. Sayer sees, and raises, moving all his chips to the center of the table. The crowd murmurs, anticipating. The first player folds. Titus considers a moment. He gestures with his left hand. He gazes steadily at Sayer. He sees the bid, leaving himself only a few chips at the table. Sayer considers this, drumming his fingers on his cards.

"Will you accept an IOU?" he asks.

Titus nods.

Sayer produces a note equal to the sum value of his assets.

"Raise," he says.

Titus considers the amount, and fingers the meager looking stack before him.

"Will you extend the same courtesy?" he asks in his flat monotone.

"You ought to debug your program first," Sayer replies evenly.

Titus produces a note. "This is a receipt for a bit of zoo excess." He places it at the center of the table. Then he looks to Hawthorne. Hawthorne blows smoke in Virgil's direction. "And this is my promise for the balance. Call."

Titus gestures with his left hand, and his features loosen, and turn to a triumphant smile. He begins to turn his cards, gazes at Sayer, who to all outward appearances looks worried, and stops short.

Sayer turns over his five cards, all clubs. A flush. Titus hasn't moved. Hawthorne reaches over, and turns the cards. Three aces.

"Should have debugged." Virgil says. He pulls in

the winnings.

A murmur from the galleries grows to a roar, and general pandemonium.

Hawthorne glares at Titus.

"He did it," I said.

Beside me, Eve added, "Again," and left. Not wanting to take my guitar through the crowd, I figured I could see Virgil at the exchange shop in the Shambles.

Virgil arrived a little after I did, and had shaken most of the enthusiasts and their congratulations.

"Now what?" I asked. Virgil stepped to the counter and dumped the pile of chips. He turned to me, slipping the receipt, and Titus' note from his pocket.

"More of the same, I suppose," he replied. "Thanks for your help."

I looked into his face and tried to read it. He showed no enthusiasm. Just a kind of relaxation. Once I'd been concerned about how much I should like him. Pointless now. He grew awkward under my gaze.

"I haven't done much in the way of making friends for a long time," he started. Then, "When does your turn come for a shuttle?"

"Tomorrow."

He thought about that for a long moment. "It never seems like there is a whole lot of time."

"Well, there's ways, and ways of spending what you've got." I turned and started to walk out. An interruption from the clerk halted me.

"Sorry Virgil, but Emory hasn't got enough to cover this."

"You sure?"

"I could check again."

"Don't bother. Just process it."

Virgil saw me looking inquisitive. "That's all I can do right now." He stepped outside into the narrow

street.

"Can you get the money?"

"Yeah, with interest. The courts will see to that. A little slice off the top of his paycheck for the next several years." He bit his lip and muttered, "I should have made sure."

"Can you pay fare now though?"

He pondered briefly. "I'll have to hock some of my gear, if I want fare and a reasonable amount of working capital." He crossed the street and paused at the window display I'd seen before. A holo image of a winged horse pranced and strutted. Next to it was an image of a creature that looked part lion, part reptile. A "sold" notice hung over it.

"How come Titus defaulted?" I asked.

"It was Hawthorne that defaulted," he replied. "Emory must have had to pay off Hawthorne for arranging things. You saw their little interchange before the bet?"

I nodded.

"Not legally binding," Virgil said. "If I'd asked for a credit check he'd have made the deposit." He paused. "I'll have to scalp a lot more innocents than usual to get my gear back," he sighed. "And I won't be able to work until then."

He gazed at the window display and fingered the receipt.

"And I'll alienate the powers more and more, close the doors."

He looked at me and fingered his beard.

"Like you said," I commented, "they'll open up someday. I don't think you should give up your chance to live your kind of life."

Virgil walked into the store. Shortly he strode out, carrying a second receipt. A "sold" notice flicked over the winged horse now too.

"A matched set," he said. "I'll see you on the shuttle. I'm going respectable."

"I just don't understand you."

We floated near a port where we could watch our approach to the shuttle dock. The Providence twin cylinders loomed up before us. Islands of life in the void. We'd just begun to match spin for the final approach.

"Did I tell you," he began, "why they always play the Blue Danube for dockings?"

"You've given up."

He laughed.

"Tell me something," I said.

"What am I going to do with a winged horse, a chimera, and a job picking up freight?"

"For starters."

"Would you do me a favor?"

I hesitated answering. Virgil was looking awfully clever.

"Peggy's wings are just decorative at present," he began. "I need you to teach her to fly."

I scowled. He knew what that meant.

"I just need her for one flight. I'll give her to you in return."

"Virgil," I mulled over what I wanted to say. "You manipulate people when you play . . ."

He furrowed his brow, and locked eyes with me.

"Do you ever use the ability with me?"

"I'm very fond of you," he said.

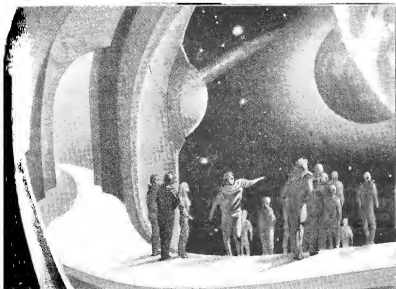
"That isn't what I asked." I felt a flush go over my face.

"I've never tried to get you to do anything, or lead you on."

"What have you done?"

"Concealed thoughts." He broke off his gaze. "On occasion I have desires I don't feel at liberty to express." He met my eyes again. "Does that answer your question?"

Honesty without invitation or commitment. I still didn't know what to think of him, but I agreed to take



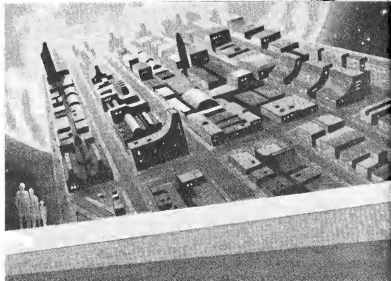
on Peggy.

Providence. The best way I can think of to give an impression of it is to describe an experience I had Earthside, during orientation. A group of thirty of us were gathered in a corner room on the seventeenth floor of the orientation center.

"I'm sure that you've all seen paintings, films, and models of O'Neill-type habitats," began our little uniformed instructor. "But I don't think you should let yourselves take the idea for granted without first being awed by it." That was all the warning we had. He turned and pointed to what we thought was a big panorama window, curving around two walls. It showed a familiar, but still spectacular view of the city.

"Imagine if you will," he said, pointing with a grand gesture to the scene before us, "taking three strips of land, about three kilometers by thirty kilometers . . ."





At that moment three sections of the city and surrounding area of that size, including ours, pulled themselves out of the ground, complete with buildings, parks, foliage, and waterways, and rose in the air.

Everyone at least jumped. Several people screamed or gasped. And those most at home with the darkride experience shouted approval.

" . . . and taking them into space."

Special effects lifted us quickly, leaving the Earth to dwindle to moon-like proportions. A fellow next to me groaned and put his head between his knees.

"Then form a cylinder, joining the land with glass sections . . ."

These duly appeared. The six massive-appearing panels positioned themselves after a brief aerial ballet.

"Cap the ends. Spin for gravity. Provide mirrors to bring in sunlight."

These things were done.

"And of course air to breath. Clouds will form at the kilometer level."

A bluish tint fell over the upward curving horizon, the overhead landed sections, and the distant cylinder end. Clouds formed into a concentric cylinder of fluff. None of us noticed the instructor leave. We just looked about till the view faded, silent and eager and sparkling, or silent and afraid.

I remembered that experience as I looked out into Providence. The lay of the land and the architecture looked different, of course. In fact, from our entry point near the axis you could see where landscaping was still under way in places. The reality of it set a harder edge to the feeling of vastness, and the feeling of vulnerability in riding a tiny bubble of life in a great sea of darkness. Even so, I wanted to get to the floor and walk as far as I could to make sure that I wouldn't bump up against a darkride screen, and find a door to normality.

Then I noticed the flyers. Several types of flycycles performed aerobatics near the axis. Many of the flyers looked lighter and speedier than those I had flown back on Earth, as if designed solely for use near the axis. A broad landing area set at the cloud level catered to them.

We descended to the floor with a ritual climb down two and a half kilometers of stairs. Then we began the hectic days of getting moved in and learning our way around to our jobs. I began my acquaintence with the farming modules haloed around the end of the city. When at last I got some free time, Virgil showed up. He asked if I wanted to meet the horse. I accepted.

On the way to a skimmer that took us across the glass to within a short walk of the darkride park, he described his work. He explained that he wouldn't have to leave Providence to chase freight due to the

use of telefactores to pilot the tugs. Visual and tactile feedback systems allowed the pilots to control the actions of robots in the tugs as if the pilots were present.

"How do people treat you?" I asked.

"Like they want to ask a lot of personal questions."

"Such as, Why did you leave the Queen? And what are you going to do with the horse and chimera? And et cetera?"

"Et cetera yes, and exotics yes. They don't ask why I left the Queen. I hear that I left for a woman."

I stopped.

"People talk about you. Didn't you know?" He spoke without mockery, but no real seriousness. More an elegant amusement. I tried to put the awkwardness I felt back to him.

"Are they right?" He fielded it gracefully.

"I tend to think of us as platonic friends."

"And that's all?"

"What more could we be? We haven't spent all that much time together."

"Then why the talk?"

He shrugged. "It doesn't take much."

"What exactly do people say?"

"The usual for such things."

I chewed on that for a moment, remembering some conversations I'd had. Cursing the situation wouldn't change the taste.

"Now what?" I said.

"Nothing, with your permission," he said. "It helps me."

"How?"

"I came here to get a respectable job." He paused, leaving the thought incomplete. He had one job already, so that wasn't what he meant. And he told me that the darkride park had no use for a stop-motion artist. Something else then.

"How will the rumor of romance help you get any

job?"

He smiled, pleased I was trying to figure things the hard way. "It removes any specter of defeat from my image."

And in what respectable endeavor is image most important?

"How in hell do you think you are going to get elected to the city council?"

He laughed. "Planning, preparation. Any citizen is eligible. I've targeted the social factions I'm likely to pick up."

I felt frustrated and angry and burning inside. I shook my head. "It's stupid, Virgil," I cried. "The public sees you as an outlaw. You're synonymous with decadence."

"Have you known me to be foolish?"

"Yes!"

"Generally?" He grew impassioned.

I thought about it. "No."

"I've got fame going for me already. In a couple of weeks I'm going to kill the chimera." He paused again to make me think about it.

"All right," I said. "You'll get the hunters on your side." If they could keep the killing going, they had political clout.

"Then a little while after that, I'm going on the talk show. The subject will be me. I'll enlighten the public on a few things, and announce my intention to run."

"And the horse?"

"More attention-getting—to start the active campaign. Everything should follow on inertia."

He looked confident. The kind of look that became infectious.

"Some people won't be pleased," I said.

"I expect not."

The stables and pastures were placed a convenient distance from both the darkride park and research

center. The stables were built of stone and metal. The pastures were fenced in with metal posts rather than the gnarled and rotted wooden posts I was used to. Neither that alien-ness, nor that of the upward curve of the horizon quite prepared me for Peggy.

To begin with, a horse, brilliant white with a shaggy mane. She seemed streamlined to me, especially about her flanks. At the shoulders where her wings joined, she was oddly, but strongly muscled. It was the wings though. They were big and feathered, and it looked as though she ought to be able to fly then and there. I was hooked.

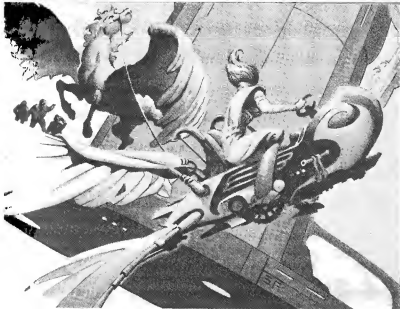
Virgil stayed with me as I got to know her by walking her about the green. I agreed to help him on the stated condition that after he used her for the campaign, she was mine. I offered to help perpetuate rumors for free.

On the way home, Virgil detoured us through a hall where victors and kills from the hunts were holo displayed. Walking past the smiling figures with rifles posing over inert trophies, Virgil paused before a grim-faced man holding a spear over a hydra.

"This guy is teaching me," he said.

My plan for teaching Peggy to fly was simple. I led her around the pasture and rode her; in general getting her used to me. I measured her for a safety harness. Before long, I arranged to take her over to the freight elevators and up to the flight landing to get her used to the low-g. That got me a lot of abuse from the local clowns, especially when I took Peggy down again without testing her wings.

After I'd done that a few times, I brought her up in the harness and tethered her to a flycycle. Then I pedaled over the edge, pulling her with me. She screamed and struggled all agawg in the air, and when I brought her back, she plowed into the landing like the biggest gooney ever.



By this time I had a gallery of hecklers. I constantly mumbled proverbs on self-control I hadn't bothered with since karate school. Then one day, Peggy figured out what wings are for. She got control of herself in the air, and made a sound of exaltation. I followed her till she got tired and pulled her in. The next time up, she pulled me off the landing. I helped her to a good elevation, where flight is almost effortless. She developed a marvelous sense for the corridor of low-g and a grace and exhilaration in flight.

At last I felt ready to try riding her. I ran my fingers into her mane and pulled myself to her back. Then I prodded her toward the edge. We hesitated. One of the hecklers (by now jealous admirers), offered to tether with me for safety's sake. I smiled sweetly and told him where he could find a good plate of manure. Then I urged Peggy forward. She strode, then leapt over the edge. Suddenly it was a kilometer down. I

made a sharp intake of breath, and the hair prickled on the nape of my neck. Peggy worked her wings powerfully, and we rose steadily. I clutched her mane tighter, but sat straighter and laughed. Only once after that did I ever settle for a flycycle. From that moment on I began to think of her, not as a horse with wings, but a big bird with an excess amount of horse-ness.

While I was busy with Peggy, Virgil labored with his various preparations. One day he came by to chat, and invited me to the darkride park.

"How long since you've been to one?" he asked.

"Five years, I think. I got out of the habit at the university. I did have an experience during orientation." I described the experience.

"It might take some getting used to."

"How do you figure?"

"Some people have a way of forgetting how involved they got."

"Fat chance. You don't know why I got out of the habit."

"I can imagine."

The park spread over a couple of kilometers, extending to the glass on either side of the section. A park with holo displays of various kinds of animals, exotics and natural, surrounded a central complex of buildings that housed the darkrides. Many people wandered in the park. Often parents led children from animal to animal, answering millions of questions, at times holding the kids back, at times comforting the fearful.

The general nature of the passersby changed as we moved among the buildings. Courting couples, cohabs in various combinations, and clusters of young adults walked and chattered, sometimes encouraging one another to try an unfamiliar, or too familiar ride. People sat on benches talking up, or

shaking off recent rides. The buildings reflected the themes of the rides they contained, and were grouped and stacked accordingly.

We took in a dozen or so, sampling the various types. Macro-type rides where we'd sit unencumbered with the illusions around us. Micro-types with the exoskel suit fitted with programmed visuals, sound, and tactile feedback allowing us to experience deep-sea diving, deep-space exploration, or combat in medieval armor. Plus variations.

We were resting on a bench after Virgil had knocked the wind from me in a medieval combat. I'd made the mistake of suggesting I take his place in the duel with the chimera if I unhorsed him. He reassured me as to his competence. Not that I hadn't gotten in a lick.

"Who's side are you on in the great darkride debate?" Virgil asked, touching his mouth gingerly. "Are they just direct access to fantasy, or . . ."





"Intersection with reality," I finished. "Definitely. Something of each one stays with you. Especially in releasing the impulse to violence at will. It changes you, for better or worse, I don't know. And being able to encounter something terrible, then just close your eyes, and sure enough it wasn't real. But there is an intersection. You do keep something."

Virgil nodded. I wondered how he felt about doing it to people. Creating a temporary reality. Someday I should ask him about solipsism.

"Dawn Patrol—Flying Circus." He pointed to a ride on the upper level of the structure across from us. "Must be one in every park ever built. Game?"

I shook my head. "Getting shot down might ruin me for Peggy. Vertigo."

He smiled. "Okay. You notice I didn't argue about keeping traces."

"I quit for a while because of it."

"I ought to get down to business anyway." He slipped a key from his pocket and fingered it. "I'll get in touch with you later." He stood and moved towards a ramp leading up to the higher levels.

"I'm in no rush to leave." I hurried along beside him. "And you've got me curious."

Virgil led the way up a couple of ramps, and across a walkway. He stopped in front of a closed darkride. The sign announced a time safari. An illustration pictured a Tyrannosaurus Rex looming over people with rifles.

"Every now and then good, concerned people put sensors on the most devious rides so they shut down if a passenger becomes too fearful." He slipped the key into the lock, opened the door and led the way in. After finding the light switch, he closed the door behind us.

"How thoughtful." I looked around. The lobby had a white on white antiseptic look. "I take it this one hasn't been castrated yet."

"Nope." He keyed open another door and stepped through. I peeked in after him. Virgil had found a switch box. The room, plainly the projection center, was crammed with several tiers of horizontal seventy-millimeter film cans. They nearly buried the projectors. Virgil flipped several switches, turned some knobs, mumbled a little, then closed the box and came out. "It's ready."

"Why this? Getting up your nerve for the chimera?"

"You got it."

"It seems a reasonable way."

"You don't have to come."

"Always, always the gentleman," I returned. "How archaic." I proceeded to open the door to the ride for him. He chuckled and walked in. I selected one of the seats in the semi-open coach. There were two large rifles mounted on the platform extending in front of the seats. Another weapon rested in a rack beside me, and another across on the other side. Virgil sat opposite me, stretching out his legs. A voice came on, mixing hype with instructions. The rifles would be effective against the Rex, it said, but only at certain intervals, signaled by the sights illuminating.

"That's so they can splice alternative endings in," Virgil commented. "I hear the last track gets very intense."

The area around the car went to a hazy gray, interspersed with rainbow flashes streaking through. Then the scene resolved into a prehistoric rain forest, teeming with life. Insects buzzed among the flora and flew through the car. The scents of exotic flowers came in on a light humid breeze and soon blended with the musk of nearby reptiles and the water flowing nearby. Off to the right a dog-sized reptile chased something indistinct through the bush. A trachedon nearby rose suddenly to its hind legs to a three meter height, and reached with its hands to pull a fern to a

bill-like mouth.

I looked back to the rear of the car. The sights continued around, even through a window in the door. The sun had set. I heard a screech overhead. I stepped out from under the half canopy in time to see a pteronodon soaring by, something dangling in its talon. A full moon shone in the dimming light.

"It's beautiful," I said. I looked back at the nearby trachedon. The beast had paused in its chewing to watch the flying dinosaur go past. I watched it fascinated. Intellectually I knew it was a small model, filmed in stop-motion, made of synthetics layered carefully over intricate armature, and painted to look like skin and hide. But it chewed and breathed. It looked at me and blinked, twitching its tail in serpentine slidings. I could smell its stink. Sensory input assaults and breaks down the borders of reality. Insistent and upcompromising. Magic.

I spoke then, for the same reason that most people speak on darkrides, an attempt to remind yourself that it isn't real, and a sure sign you've been seduced.

"This kind of thing is done in lots of parks, isn't it?"

Virgil just nodded, looking around.

A sudden stillness sent a chill through me. The trachedon stopped chewing. It turned to look across the clearing ahead of us. A gut rumbling bellow tore through the moss-draped trees. The trachedon turned and strode past us, the size of it pressing home as it jostled up against the carriage. The Tyrannosaurus broke into the open on the far side of the clearing. The massive head towered over medium-sized trees. The thick tail twitched from side to side in agitation as it shifted its weight on thighs like hydraulic wine barrels. The cruel eyes locked on us, and it roared through dagger teeth like stalactites and stalagmites neatly arranged in a red cavern.

"Nice effect," Virgil said. I was pleased that he had spoken.

"When do we shoot?" The rifle had gotten to my hands. The sights lit up.

"I planned on waiting it out," he said.

The beast glared and snapped its jaws hungrily. Not real, I thought, the gun barrel rising.

"People used to favor this one for playing chicken," Virgil went on. "A weak heart or two clued the good, concerned people." Voice steady. His knuckles white on the seat.

"Wonderful," I muttered. I put the rifle back. The sights flickered derisively.

The ground trembled with the footfalls of the beast. It loomed higher in the sky. It paused to roar again, the moon silhouetting its skull. The gun sights flickered again. The breeze carried a smell of death. Twenty meters away. The gun-sights flickered on again. Suddenly the beast made a final lunge towards us. Virgil cursed and grabbed for his gun. A great taloned foot crushed down on the front of the carriage, tilting the whole thing. I fell. The open jaws dropped, fouling the air. I heard screams in three different octaves. The head reared back with arms and legs dangling from bloody jaws. A nearby tree fell on it. The scene dissolved into gray and colors drifting.

I looked over and saw Virgil on the floor, sitting up with his back against the seats. Perspiration covered his face. He took a deep breath and looked at me, smiling weakly. I took my fingers from my mouth and muttered, "Never again." Virgil shook himself and wiped his brow.

"Now what?" I said.

"I do it again. It will be just as real. But this time I shoot. At the last moment."

"And in comparison," I added, "the chimera will be cuddly."

He nodded. I got up from the floor and sat.

"I'm game," I said. Between us we killed it eleven

times.

The chimera spent its waking hours lurking about in a desert area a few kilometers from the park. Virgil took me to a place where they dropped food to it, a seven meter deep amphitheater-like place at the end of one of the deep gullies that meandered through the area. The highest ground was hollow, a fact made obvious by the landscaping going on further along.

"The darkride people will have three cameras going," Virgil explained. "There, there, and here."

"In spite of everything, it doesn't seem like you to be doing this."

He shrugged. "What does seem like me?"

I couldn't answer that. "It isn't too late to settle down and pilot shuttles. You could work on your art in your spare time."

He shook his head. "I've wasted way to much time already."

"You know who I feel like? Rosencrantz and Guildenstern. Unimportant and only accidentally involved."

"They were involved enough to die, even in the Stoppard version."

"Especially in the Stoppard play. They served to anti-romanticize death. You die, and that's that. Nothing. Gone. No acting and coming back in a different hat."

He stood silently for a moment.

"Virgil?"

He sighed. "Be careful?"

"Yes."

Change of scene. The amphitheater is illuminated against the progress of mirrorshift, giving the setting an unreal quality as a pool of light in the deepening darkness. The cameras are in place, each crewed by two. I stood near the third camera, arms folded as if

against a chill. The crews spoke in their jargon, making sure of their equipment. A medic and a reporter, whom I recognized as Brian Carr, the talk show host, bantered on, telling Sayer stories. Idle thoughts and idle chatter ceased as the chimera entered from the gully.

It paused at the entrance to look things over. A lizard tongue flicked in and out. The shaggy mane and dusty brown fur covered the head and torso. Gray-scaled leathery hide ran over the nose, snaked tail, and the squat reptilian legs. It moved forward in a lumbering slither, rather than a feline stride. It looked more pathetic than monstrous as it moved, looking for food that wasn't there. It stopped nosing about when Virgil entered. With him there for scale, the creature took on a fearsome aspect. Three meters from head to flanks, longer with the tail. It watched him. The cameras hummed and muted directions were whispered.

Virgil moved warily, carrying a two-meter spear. A sword and dagger hung sheathed at his waist, and he wore a thick vest, heavy leggings and long gloves. He halted just inside. The creature tilted its head and roared without menace, seeming to be asking where dinner was. Virgil hefted the spear. It had a long leaf blade, and a cross-bar part way down the shaft. The creature nosed about further, then approached the gully exit, pausing a few meters from Virgil. It cried out again, then suddenly scurried forward, trying to skirt around Virgil. Virgil moved quickly, blocking its path and thrusting the spear into the creature's breast.

It scrambled backwards with a cry of fear and pain. Virgil advanced carefully. The creature moved first to one side, then the other. Then it scrambled part-way up the walls, as far as its claws could gain purchase, and began to creep along toward the gully. It passed below us, but out of Virgil's reach. It breathed



in great rasping gasps, nails clicking on the face of the walls.

Virgil ran ahead quickly, drew back his arm, and cast the spear. It penetrated just behind the chimera's right shoulder. It fell with an agonized cry. Virgil moved up, drawing the sword for the kill. The twitching tail bumped up against Virgil, startling him into hesitation and warning the beast. It spun around, roaring out in savage rage, lashing out with its talons. The blow caught Virgil across the chest, hurling him back five meters, leaving the vest shredded and torn and his breast gashed and bleeding.

The chimera paused then, its cry turning again to pain, for the sudden movement had worked the spear deeper in the wound. It tried to worry the spear, buried now to the cross-piece.

Virgil looked up from where he had fallen. He rolled cautiously, rose to his knees, looked to the beast, then to where the sword had fallen. He got to a

crouch, the dagger glittered in his left hand. The beast snarled pain and challenge. He moved to sweep the sword up, and around as the chimera lunged. Hampered by the spear and beaten down by the sword, still it managed to close its jaws on Virgil's thigh. Virgil threw his weight forward and stabbed viciously with the long dagger, again and again. The creature stilled, its roar faded. The dagger fell from Virgil's hand, clattering to the arena floor.

I felt detached, as if watching from a silent place, kilometers distant. Slowly, as with the sensation of weight coming to you in a gradual descent from the axis, I became aware of sounds and place. I felt the veins pounding in my head, and heard the hum of the cameras and the panted breathing of the medic. Finally, Virgil screaming on and on. I whispered, "It's no darkride."

I turned and shook the medic. The crews watched me dumbly, paled. "It's no damn darkride!" They became animated all at once, and we scrambled down.

"If it hadn't been for the leggings," Virgil was saying, gesturing to his heavily bandaged limb, "it might have been bitten clean off. I'll be fine with a little care."

He sat up in the hospital bed so that he could work with the swing-out terminal placed beside him. I sat next to the bed, feeling glum and not saying anything. Virgil went to a different subject, trying to open me up.

"I've been doing research on myself for the Brian Carr interview." He waved at the terminal. "Got a lot of information sifted."

No change from my corner.

"I'm glad you came to see me," he continued. "I could use some cheering up. Eve Brooks passed through the floor this morning, comforting the in-



firmed. Passed me by . . . unclean, I guess."

"Virgil."

"Yeah."

"Why'd you start all of this?"

"Making conversation."

"That isn't what I mean."

"What do you mean?"

"Why'd you start back in the first place on the Queen?"

He eased back on his pillow, crossed one arm over his lap, and fingered his beard with his other hand.

"I used to be a goalie on a lunar mass catcher. Did I tell you that? For three dull years. I decided if I'm going to be doing something I don't like doing, I've got to be doing it for somebody, or something worth putting up with it for."

I thought about that. His something now was a combination of striking a blow for his politics, and revenge in an appropriate form. As to a present somebody, I didn't know.

"What was your somebody and something back then?" I asked.

"My wife and child. I figured to make enough money either to bring them up, or to get a good start on Earth someplace."

"What happened?"

"They died. Killed." He paused. "Nothing to go back to Earth for and the Hohmann Queen heading out. Once on the Queen I decided I'd had enough of chasing rocks. Thus and so. Here I be."

Virgil made a big impression on the talk show interview with Brian Carr. He referred to his popular image as a creation of the people who emphasized and distorted the facts like a crazy mirror according to their own needs. Folklore is a mode of expression, he said. What does the entity called Virgil Sayer express? he asked, and offered up a few suggestions. Greater social mobility. Financial freedom. Access to

cultural expression.

Brian Carr asked if gambling was a cultural wish-fantasy. Sayer replied that the gambling was only important as a focal point of excellence upon which to hang attitudes. People like to relate with the best, he said.

Then Virgil brought up the point that the present colony emphasis on simple living and hard work began as a response to accusations that the space habitats were islands of paradisiacal decadence for the rich, and that the builders were letting the earth rot. But now, he said, the grounders have felt the effects of the Third Industrial Revolution more widely. The traditions are no longer necessary.

Then he announced his intention to run for office.

In all the excitement, no one noticed that he didn't say a thing about himself. He overturned a pot of controversy that filled Providence to overflowing. He'd forced people to ask themselves what they really wanted. The more recently arrived were easiest to convince. He'd forced his opponents into defending the status quo without being able to deal effectively with the questions he'd raised. They attacked him as an irresponsible menace. The opposition party adopted Virgil with open arms. He looked to be in a strong position. He told me that he planned on flying Peggy the length of the city to start the active campaign.

Two hundred people milling about the flight landing, and not all of them equally adept in moving in low-g. It made interesting watching as we waited for the time of the broadcast and flight. A couple of newsmen were moving a camera in place. A steady stream of people moved around Peggy.

"There he is," Virgil said. He had his leg bundled up to protect it, and had been among the awkward on coming down to the departure point.

"Who?"

"Looked like Hawthorne."

"Doesn't matter, it's almost time."

"You ready?"

"Almost. I forgot something."

"What? Your pilot's license?"

"There's a name from an old myth that I want to use."

I could tell from the way he said it, glancing back towards the elevators where there was a terminal.

"You want me to look it up?"

He nodded and smiled for good measure.

"Okay," I said. "What is it?"

"A Greek myth. About a character who bridled the winged horse Pegasus and slew the chimera."

"Sounds appropriate."

"Very. He was helped by the goddess Athena."

"I believe I have been complimented." Virgil surprised me by bending over to kiss me.

"One more thing," he said. "I'm going right now, and you won't be back in time. Just wave and mouth it. I read lips."

"I can tell," I laughed.

I made my way back to the terminal. Bellerophon was the name Virgil wanted. I waved and mouthed it. Then he gave a little speech. Brief and witty, he recapped what he'd said on the interview. There was a healthy spattering of applause from those gathered. Virgil moved over and pulled himself to Peggy's back. Seconds later they were off. I felt a tinge of pride watching Peggy, and jealousy seeing her go off with someone else. Mirrorshift had progressed enough for the sky to be dusk-dark. They moved gracefully down a scanty tunnel of clouds, each wing stroke making them smaller, coriolis effect twisting them out of line.

I looked down to turn off the v.t. screen. The story of Bellerophon was before me, in my hurry I had not read it. By some accounts a son of Poseidon and so destined for a dramatic life, he'd been falsely accused

of raping a king's wife, and as punishment sent to kill the chimera. Athena aided him by giving him the bridle of Pegasus. After his successes, he began to think thoughts too great for man. He aspired to a place in the city of the gods, and so mounted Pegasus, and flew to gain entry. The gods, offended by such hubris, sent a gadfly to sting his mount. He fell . . . no.

I ran. They were high in the distance, near the axis. I stumbled into a man, knocking him down, and falling.

"What do you think . . ." he started. I recognized Emory Titus. I kicked him full in the face. Then I bounded to the hanger, grabbed a flycycle and flew after Virgil.

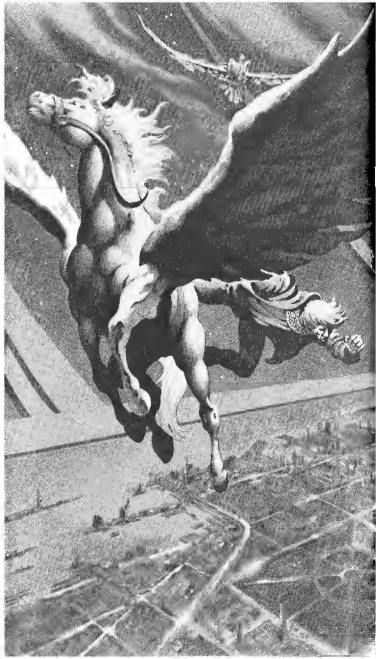
He was far ahead, perhaps two kilometers. There were shouts behind me. I pulled up for elevation and greater speed. Most of the shouts faded. I pedaled furiously. My legs began to ache. Far below dots of light marked the population centers. I looked back to the landing once, a reef of light in a growing sea of gloom. Two flyers followed after me. I pulled away from them, gradually catching up to Virgil. Hard to see them . . . there . . .

As fatigue grew in me, I felt the first inklings of doubt. I glanced back at the pursuing flyers. Chagrin levered into my jumbled feelings. I shook myself. I was their best chance. And Titus had been there. I began counting pedal strokes against wingbeats.

"Virgil . . ." I shouted, but the distance was still too far. He hadn't looked back. Despite my closing the distance, it got harder to make them out against the dusk and cloudy backdrop. Fewer lights below.

"Oh, damn," I started to slow despite myself, muscles protesting that nothing would happen, fatigue protesting over fears.

Then I saw Peggy buck about violently in the air. Horse and rider separated, drifting apart. The floor



three kilometers down.

"Virgil," I screamed.

I pedaled frantically, close enough now to hear Peggy's screams. Virgil drifted further, twisting in the air, falling so slowly . . . but picking up speed all the while. Peggy began to get control back, and beat her wings steadily to slow her descent. Virgil in comparison fell like a stone. The clouds rushed up. He fell faster, dimishing against, and finally disappearing through the clouds.

I passed through a moment later. Only dark and silence. I pulled from my dive into a turn that pointed me back to the landing. City lights blurred and brimmed over. I rose slowly through the clouds. Two flyers overhead led Peggy back. I followed heavily.

By the time I got back, the news of Virgil's having fallen had likely gotten to everyone in the cities. A search for the body was being organized. Newspeople were on hand to question me. They were already quoting prosperity party people as saying that a reckless fool had come to a timely end.

The first thing I did was to have Peggy checked over. We uncovered a small burn. I accused Titus of putting a stinger on Peggy. Unfortunately we could produce no witnesses who could testify that they had seen Titus anywhere near my horse. He had plenty of reputable witnesses to the contrary. Also several who could testify that they had seen me assault him without provocation causing significant bodily and mechanical harm. He invited me to a lawsuit in my honor.

Sitting in detention a few days later, I got a visitor. A short portly man with dark skin named Lyle Saar. I knew him by reputation as a member of the destiny party, and instrumental in convincing them to adopt Virgil into the fold.

"Natalie Schofield?"

"That's me."

"You are in trouble."

"Trouble," I laughed bitterly. "I'll be out soon enough."

"And you'll be giving twenty percent of your pay to Emory Titus for the next twenty years." He sat next to me on the bunk. "That doesn't leave you much."

"I'll live."

"Not well."

"What's it to you?"

"I have a proposal."

"I'm listening."

"Or at least, I may have a proposal."

I stood and walked over by the bars, leaning against them.

"Depending on what?" I said.

"The results of the investigation."

"If Titus didn't do it, then Hawthorne must have."

"Hawthorne has an alibi," Saar said. "He has all kinds of witnesses. He wasn't even up at the landing."

"You sound as though the investigation was settled."

"Not yours."

"Me?"

"You proved it was no accident," Saar said. "And a crime of passion would affect the elections far less than assassination. What's going to happen when they question you?"

"Get out," I muttered.

"I'm here to help."

"So convince me."

"We want you to run for office."

I was too depressed to think of a punch line so I just snorted.

"For which," he went on, "we would pay your debt to Titus."

"Even if I were an aspiring politician, which I'm not, you just said I'm being investigated for murder."

I turned and hung my arms through the bars.

"Exactly our problem," he said.

I turned and looked back at him. His expression implied that he had no ideas at all.

"Thanks for the help," I mumbled.

"With you as a masthead, we could win enough seats to bring about some changes." He paused. "Are you in the clear?"

"Look," I shouted. "I'd never have even thought of me. But Peggy's my horse, and all that's left of Virgil is a bucket of gore."

"Are you in the clear?" he said calmly. "Can we use you?"

"I don't need to be in the clear. Only the guilty need alibis."

"But Titus is in the clear. And Hawthorne wasn't there."

I remembered then. "But Virgil saw him."

"Impossible," Saar said. "He was working. Max Widengren was among the witnesses."

"Working on what?"

"I don't know."

I had an idea. Virgil saw people, not just as a face and features, but as a kinetic pattern. Suppose Virgil did recognize Hawthorne, despite his absence. I knew that Hawthorne had once tried to get to Virgil by broadcasting sensory information to a suitably cyborged person. That implied the capacity to broadcast physical commands, in effect, interrupting the brain's commands, and using a suitably wired person as a telefactor.

"Lyle Saar," I said, "Get out of here." I savored his disappointed expression. The matron came and let him out. "And when you see the sherlock who thinks I did it, have him find out who else on the landing besides Titus was a cyborg."

"Why?" He brightened.

"So they can peek inside."



"You've figured something."

"Then you can get me out of here and put Hawthorne in."

"Then we can use you."

"Somebody's always using somebody," I said. "I don't owe you if I lose."

"You won't lose."

I was right. And he was right. A bunch of council seats changed. But the biggest change was in attitude. We got rid of Hawthorne, and sent him to keep his nephew company. Titus we exported for fraudulent entry. Evangiline Brooks faded from the political scene, caught in the backlash for no good reason. We've got a symphony, a theater company, a ballet, a load of artists and performers of divers creative modes, and a growing economy and population. We aren't yet decadent, but we are much less pious. Open. Some people left and went to homestead the rocks. I've won another election. I've been neither frustrated nor lonely, at least no more so than I could handle.

End of story.

Epilogue.

One day I took in a darkride called The Black Mountains. Inside I rode a balloon gondola up the face of a cliff, and over an ensorceled battlefield. There, among other things, I saw Zapranoth and Draffut. I asked around and found that the effects for the ride had been done locally. I sought the artist out, and visited him at his home.

"Hello, Virgil," I said.

"Hello, Natalie," he said. "Would you like to come in?"

"No."

"How is it with you then?" he asked. The beard was gone and the hair a different color, but he'd changed more deeply, or perhaps a different light brought up

other facets.

"Oh, you know," I said. "Public people have no secrets."

"I knew what they were going to do."

I cleared my throat. He continued.

"I planned on it from the start, and pushed for it."

"You padded your leg with a para-foil," I said.

"The landing was still a little rough," he commented, nodding.

"How so?"

He showed me that he had a prosthetic leg.

"Oh."

"By the time I recovered sufficiently to learn of your troubles, you'd already figured the Hawthorne trick, and begun the campaign."

"You had help. A doctor, and someone to help you with a new name."

He nodded again. "I didn't want to put you in a position where you had to lie, but I tried to tell you."

"How?"

"Bellerophon."

"How?" I repeated.

"He survived the fall, and lived out his life in obscurity."

"Oh." I remembered. "I didn't read that far."

"I guessed later."

"And why this?"

"I planned differently," he paused. "I got a visitor in post-op at hospital."

Vague recollections surfaced.

"Loosing the election hadn't stopped her humanitarian visits, and I'd forgotten them." His eyes glazed over momentarily at the recollection. "She recognized me, but decided not to make noise till she asked why."

"And?"

"I told her. And we talked. And somehow . . . we seemed to fit."

"I see."

"I suppose it's what I always wanted. A home and family."

In my head, a kalidostorm of feelings raged. Exhilaration, disgust, the anguish I'd known, the glory, the burden . . . and Roxanne's last words to Cyrano, Rhett's to Scarlet. I choked them all off, not sure at that moment which were true.

"Are you happy?" I finally said.

"Yes," he said softly.

"That's really all I wanted to know."

". . . I'm sorry."

". . . Whatever for?"

Call it the stuff of legends, when you hear it. And consider the sight and the setting; an inside-out world. I ride Peggy often. And someday when it no longer matters, I'll speak my knowledge.

—Kevin Christensen



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"SPACE IS BIG."

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# GETTING ABOUT IN SPACE

CHARLES SHEFFIELD

## INTRODUCTION

The U.S. Space Program is almost a quarter of a century old. In that twenty-five year period, this country has spent about sixty billion dollars\* on space-related work.

\*This does not include defense-related space expenditures. Including them would push the total close to one hundred billion dollars.

That may sound like a lot of money, but we should remember two things. First, sixty billion dollars would keep the Department of Health, Education and Welfare going for only about *four months*; second, ninety-nine percent of our sixty billion has been spent on *getting to space and getting back*—only a couple of billion dollars, total, has been used to look at methods of *space travel*, of moving efficiently in space once you are there.

We'll be concerned with travel in space, so it is important to note how that differs from getting there in the first place. If we were permitted to choose a place from which to begin space exploration, the surface of the Earth would be one of our last choices. We sit at the bottom of a deep gravity well. Before we can consider flying off to Mars or Venus, we first have to climb up to low earth orbit. As Robert Heinlein remarked, once you are in that orbit you are halfway to anywhere.

A second significant factor is earth's substantial atmosphere. Since we use it for low level flight, it may look like an advantage for higher flight. In fact, the air that surrounds us limits our options on the ways that we can get to space. We cannot, for example, employ the method that Jules Verne used in his 1865 novel, *From the Earth to the Moon*. He fired his space travellers into space from the giant cannon of the Baltimore Gun Club, embedded in the ground in Florida. To escape from Earth and reach the Moon, his voyagers needed an initial speed of about 11 kilometers a second. They achieved it by acceleration along the barrel of a nine-hundred foot cannon, propelled by the force of exploding guncotton. They would have experienced an *average* acceleration during the first nine hundred feet of more than 22.000 gee—enough to give anyone a headache. By the time they reached the end of the gun barrel, the travellers



would have become a thin layer of flattened protoplasm in the bottom of their space capsule.

Suppose they had been not men but robots, designed to withstand very high accelerations (instruments have been built to operate correctly after accelerations of more than 50,000 gee). Would they then have been launched on an orbit that could reach the Moon?

Unfortunately, they would not. Verne dismissed the effects of atmospheric drag and heating, arguing that his travellers would be exposed to it for only a few seconds. But those few seconds would slow the spacecraft significantly. If it did not simply disintegrate before it escaped from the atmosphere, it would still be slowed too much to achieve orbit.

Early experimenters on travel to space recognized the problem with Verne's method, and they sought other means of reaching orbit. As we shall see, there is a subtle chain of difficulties, a Catch-22 of space flight, that would make the pessimistic argue that Mankind was never intended to leave this planet at all.

Consider the following logic. Since we find that we cannot *throw* an object into orbit because of the resistance offered by the air, we ought to somehow be able to *fly* it there, using the same air that makes the cannon shot impossible. Now, all the methods of conventional air flight rely upon the presence of the atmosphere to provide lift, so aircraft and helicopters can never get us to space. We can conceive of an aircraft that flies so fast that it leaves the atmosphere and soars off to space with the speed that it has built up, but this doesn't work either. The single-stage-to-orbit (SSTO) vehicles use airbreathing propulsion, but they follow it by rocket assistance. The idea of an SSTO without rockets is not theoretically impossible, but I have seen no practical designs that do not

include the rocket phase.

If we cannot use purely ballistic devices to throw us to space, and if we cannot use some form of aircraft, what is left?

All that remains is the rocket. It is no surprise that we are led to this conclusion, since *every* launch to orbit has been made this way. But in some ways, the rocket turns out to be the worst choice of all.

(Readers of DESTINIES #4 will realize that I have omitted one significant option. The Beanstalk described there avoids all the problems of rockets, aircraft, or ballistics, and represents the best method for reaching orbit. But that device will not be available for at least fifty years.)

To see the big problem with rocket propulsion, imagine that we have a rocket that can provide a significant thrust for many hours (even days or weeks), without requiring any added fuel (rocket fuel is the "reaction mass" since the rocket is propelled forward as a reaction force against the expulsion of the fuel). We place our rocket upright on the launch pad, switch on the engine, and the propellant is expelled from the base to provide an upward thrust. What happens next?

One possible answer is, "Absolutely nothing." If the total thrust generated is less than the weight of the rocket and its fuel, the whole thing will simply sit there. Earth's gravity provides an effective "downward thrust" equal to the rocket's total weight. Unless the upward thrust provided by the propellant's ejection exceeds that weight, the rocket will not move one inch. We will waste all our fuel without achieving any movement at all.

This is the worst case. A slightly better situation arises when the thrust of the rocket's engines is a little bigger than the total weight—say, one percent more than that weight. The rocket will now move upward,



but it will do so very lethargically, with an acceleration of only one-hundredth of a gee. You *can* get to orbit that way, certainly, but it will take you a very long time to do it. And for all that time, while you move slowly upwards, your rocket is wasting thrust, with almost all the fuel being expended to counteract the one gee downward acceleration provided by the Earth itself. It is close to a true Red Queen's race, pushing as hard as we can to keep ourselves in the same place.

Perhaps it is clear now why astronauts are trained to accept high accelerations. The faster that the rocket can burn up its fuel, the higher the thrust will be, the higher the *useful* thrust will be, and the quicker it will reach orbit. Once there, fuel is no longer wasted fighting Earth's gravity.

We see that there is almost a "quantum theory" of space flight away from Earth. All rocket engines that provide less than one gee of acceleration are not useful in getting us to orbit, and one gee of thrust acceleration is the lower limit below which launch to orbit is not possible. Once we are in space, no such quantum effect applies. Any acceleration, no matter how small, can be used to transfer between any two orbits. This is the basic difference between *to space* and *in space* travel.

There is one other method that ought to be considered for reaching orbit, since it appears to avoid the requirement of more than one gee of acceleration. I assumed that the rocket was placed upright on the launch pad and moved *vertically*. This required better than one gee of thrust before any movement could take place. Suppose instead we placed our rocket *horizontally*, on a long, smooth railroad track. Then any acceleration, no matter how small, will speed up the rocket, and if we keep on increasing in speed we will eventually be moving so fast that the rocket would have to be held *down* to the tracks. If we could

reach a final speed of ten kilometers a second, then release the rocket from the tracks, it would have enough speed to take it to a height of 25,000 kilometers from the center of the Earth—a fairly high orbit.

Again, it is the atmosphere that is the spoiler. If we had no air on Earth, horizontal rocket launches, or electromagnetic sled launchers, would be quite feasible. But air resistance and frictional heating make it impractical for Earth. For the Moon, the method is probably the best one, and it was long since suggested as a good lunar launch technique. (The first suggestion that I know for an electromagnetic sled launcher was made by Arthur Clarke in 1950, in the *Journal of the British Interplanetary Society*. Twenty-four years later the same technique was re-introduced for in-space transfer of materials by Gerard O'Neill). The Moon's gravity field is weak enough that a horizontal speed of 1.7 kilometers a second will get us to orbit, and there is no air to interfere with our acceleration.

First, though, we must reach the Moon. That puts us back where we started. Beginning the exploration of space from the surface of the Earth may be our only option, but it's a hard one to live with.

#### SIZING THE PROBLEM

Let us begin with a statement so trite and so familiar that it is easy to overlook its importance: Space Is Big.

How big? We should start with that question, because its answer sets bounds on what we can hope to do in the reasonable future. Writers of science fiction stories hop from star to star and from galaxy to galaxy without giving the mechanics of that hop more than a second's thought. We need to get a sense of scale, and to understand what that casual space-hop really implies.

Manned exploration of space has made it to the

Moon—just. Within the next ten years we may see a shot at a permanent lunar base (but not, alas, a U.S. lunar base). It seems reasonable to use the Earth-Moon distance of about 240,000 miles as a starting point, something for which we have already obtained a decent grasp.

What will we see as the next level of exploration of space by humans? We must make some plausible assumption about what our next level of technology will bring us. A quick look at scientific history shows us that progress in science and technology doesn't happen linearly with time. It comes in sudden jumps and spurts—nothing new in a field for fifty or a hundred years, then a sudden huge leap to a higher level of understanding.

Let us assume that pattern continues in the future, and let us suppose that sometime in the next century we will see a breakthrough in propulsion methods. A big breakthrough. One that will allow manned exploration to go out *ten thousand* times as far as the Moon. To give a simple comparison, a factor of ten thousand in exploration range would be like having the whole Earth suddenly accessible to us, when we had previously been confined to a radius of a couple of miles of our home village.

Where will that increased travel capability take us?

The result is disappointing and perhaps a little surprising. We would be engaged in manned exploration of Uranus, but we could not reach and explore Neptune (see Table 1 for these and other distances). Despite a huge increase in exploration range for manned travel, we would still be well inside our own Solar System.

Let us be more ambitious. Suppose that there is a second breakthrough, maybe a century later, that expands the range of accessible distances by *another* factor of 10,000. We will then have a hundred million

times the range of our present Earth-Moon compass. One might feel that this would allow us to get any place we want to.

It doesn't. We would not quite reach the nearest star, Proxima Centauri, 4.3 light years from Earth. We will be close, with an exploration range of 4.1 light years, but the stars will still be out of reach. If the factor of a hundred million in linear range doesn't impress you, think of the *volume* of space that will have been opened up to us over that bounded by the Earth-Moon sphere. It will have increased by a trillion trillion, a factor of ten to the twenty-fourth—and we still have not struggled out as far as the nearest star. As Edward Gilfillan remarked in an intriguing book, *Migration to the Stars*, exploration of such a volume will be limited by a shortage of people. We are familiar these days with the problems of overpopulation, but under-population can be just as big a problem.

Another factor of 10,000 in linear range finally gets us somewhere. We would now be able to travel and explore for forty thousand light years. This opens most of our galaxy to us, including the galactic center. Other galaxies, even the nearest ones, are still unattainable. When our hero gets into his spaceship and flies it from Sol to the Andromeda Nebula, he presumes an exploration range better than a trillion times the distance from Earth to Moon. Table 1 again gives us an idea of the distances that we are dealing with.

Let us take one final jump in range, by another factor of 10,000. This finally gets us into what we can fairly think of as *deep* space. When we reach the galaxies at the limit of our travel range, we will find that they are receding from Earth at about 4,000 miles a second because of the overall expansion of the Universe.

That is the last factor of 10,000 that we are permit-

ted. Another one would take us out past the limits of the visible Universe. Four steps of 10,000 ought to be quite enough. We have travelled ten to the sixteenth times the distance from Earth to Moon, and we have increased the volume of space available to use by a factor of ten to the forty-eighth. I suggest that both those numbers are much too big to be fully grasped by any human, and supposedly useful analogies involving grains of sand in the Sahara Desert, or railway trains running unhindered for many years, only add to the difficulty. (Alpha Centauri is just about at the distance that a healthy kangaroo, travelling at a steady thirty miles an hour, would go if he hopped continuously for ninety-one million years. I hope that makes everything clear.)

We have to set some bounds on our ambition. For the purposes of this article, I propose to make it the Alpha Centauri system. We will examine methods of travel in space that can reach the nearest stars, and be content with that. Perhaps the most surprising thing, in view of the distances that we are considering, is that we will actually find methods that may achieve our goal of an interstellar trip. One possible starship design was recently the subject of a detailed and serious study by the British Interplanetary Society ("Project Daedalus"; 1978). Before questioning the utility of that study, it is as well to remember that this is the same Society that provided a detailed multi-stage Moon rocket design in 1938-39, and a complete Space Shuttle design in 1952-53. They set the time for the first interstellar probe at about a century from now.

Side issue: to my knowledge, the observation that we can "scale up" from the Earth-Moon distance by factors of 10,000 and encompass successively the Solar System, the nearest star, our own galaxy and nearest quasars has not been made before in print. Is there any "magic significance" to the number

TABLE 1

## DISTANCES AND DISTANCE SCALES

Distance from the Earth	In miles	In astronomical units	In light years
Moon	240,000	2.58 E-03*	4.08 E-08
10,000 x Moon distance	2.4 E09	25.8	4.08 E-04
Uranus	1.69 E09	18.2	2.87 E-04
Neptune	2.70 E09	29.1	4.59 E-04
100,000,000 x Moon distance	2.4 E13	2.58 E05	4.08
Proxima Centauri	2.53 E13	2.72 E05	4.3
Alpha Centauri	2.58 E13	2.77 E05	4.38
Sirius	5.06 E13	5.44 E05	8.6
Galactic center	1.77 E17	1.09 E09	30,000
1,000,000,000,000 x Moon distance	2.4 E17	2.58 E09	40,800
Andromeda Nebula	1.29 E19	1.39 E11	2.2 E06
Virgo Galactic Cluster	2.5 E20	2.66 E12	4.20 E07
10,000,000,000,- 000,000 x Moon distance	2.4 E21	2.58 E13	4.08 E08
Quasar 3C273**	1.77 E22	1.90 E14	3.00 E09
"Edge" of the Universe**	1.09 E23	1.18 E15	1.86 E10

\*For ease of type-setting, numbers have been written in the exponent form X.XX EXX. The number following the letter E is the power of 10 that must be used to multiply the number preceding the E; for example,  $1.02 \text{ E}03 = 1.2 \times 1,000 = 1,200$ , and  $1.4 \text{ E}-02 = 1.4 \times .01 = .014$ . Multiples of the Moon distance have been written out in full to give an idea of just how far we are roaming from Earth (1.0 E16 seems less impressive than 10,000,000,000,000,000).

\*\* These entries are based on a value of 10 miles per second per million light years for the Hubble constant.

10,000? None at all, to my knowledge—we would do rather better at hitting ranges of interest had I chosen to use a scaling factor of 15,000.

## TRAVEL TIMES

The discussion of the previous section gives us an idea of the size of the regions that we would like to explore, but it tells us nothing at all about the time that we might take to reach them. We do have some information. Unless we can find a way around relativity theory, the speed of light provides us with a lower bound for the travel times that will be needed to reach other parts of the Universe. Without "worm-holes", "hyperspace", or some similar exotic method for by-passing the limitation imposed by the speed of light, no method of travel will allow us to reach Alpha Centauri in less than 4.3 years, or the center of the galaxy in less than 30,000 years.

These, we should note, are *Earth* years—years as experienced on Earth. They represent the time that would pass as perceived by someone who stayed behind on Earth and watched the travel take place. Relativity does have one advantage to counter the limitation that it imposes. It allows us to decrease the *perceived* time experienced by the travellers themselves. If we can accelerate our spacecraft until it is travelling close to the speed of light, on-board travel time appears to be less. We can conceive of a trip to the galactic center that would take only a few weeks, subjectively, but when the travellers return to Earth they will find that at least sixty thousand years have passed there.

In what follows, I am going to assume that relativistic effects are of minor significance, so that I can speak of travel time without being obliged to distinguish subjective traveller time from stay-at-

home time. Most of the propulsion systems that I will consider offer speeds far below light speed, and even if we get up to a fifth of the speed of light, time dilatation changes the rate of on-board clocks by only a couple of percent.

I also will exclude completely the consideration of all "space warp" and "hyperdrive" methods of travel. These may prove to be, in the far future, the way that all interplanetary and interstellar travel is done, but it is pointless to consider them now since we have absolutely no idea if, when or how such methods can work. This is true even where we have some scientific basis for hypothesizing their existence.

Let us begin with the simplest and most humble objectives, that of exploring and utilizing our own Solar System out as far as Saturn. The big problem here is not the distance—Voyager has already taken a close look at Jupiter, and Pioneer 10 and 11 are leaving the Solar System completely and heading for the stars.

The problem for manned travel is the *time* that these trips will take. The flight of Voyager from Jupiter to Saturn will take two years, and it will be hundreds of thousands of years, at a minimum, before the Pioneer spacecraft can approach another star.

It is useful to look at a simple example. Suppose that we have a spacecraft out at the distance of Jupiter from the Sun, and we wish to fly it in to Earth. How long will the journey be to get us here?

If our ship were initially at rest relative to the Sun, we could simply let it drop in towards Sol, without applying any form of thrust or initial boost to it. It would then fall inwards and cross Earth's orbit about two years later (737 days). If we had done the same thing out at the distance of Saturn the flight in to Earth's orbit would have taken more than five years (1,875 days).



Admittedly, the chance that the ship would begin at rest is small—it would be much more likely to be in some kind of orbit around the Sun to start with. However, in such a case the travel time would be even longer; the “radial orbit,” which is what we have used, will give a smaller unboosted travel time than any other to reach Earth’s orbital distance. The radial orbit can be regarded as a limiting case of all possible unpowered orbits with aphelion at the distance of Jupiter or Saturn, and it is that orbit that makes the travel time inwards a minimum.

We see that we are dealing with long travel times—years—unless we take some positive action, such as an initial velocity boost or an in-flight drive, to speed up our transit.

In Table 2, I have given the transfer times from Jupiter-distance to Earth-distance from the Sun for a radial orbit with an assumed initial boost of  $v$  kilometers a second. Table 3 shows the same thing for a transfer from Saturn distance to Earth distance. Both these tables make it clear that we can achieve a significant reduction in transfer time by using an initial velocity boost, independent of any in-flight drive mechanism. Of course, we will need some way of catching the ship as it crosses Earth orbit, by providing a velocity decrease to it, otherwise it will go straight into the Sun. The more the initial boost, the greater the final speed at Earth orbit. We will defer the question of how this velocity decrease is to be achieved. Any method that provides initial velocity boosts and no in-flight drive will be termed a *pure ballistic*\* transport system.

\*Most of the systems now used for maneuvers in space are rockets, but they are fired only briefly, at the beginning and end of the maneuver. Thus most spacecraft follow paths that look much more like ballistic trajectories than true powered paths.

TABLE 2

## TRAVEL TIMES FROM JUPITER TO EARTH WITH RADIAL ORBIT

<u>v in kms per second</u>	<u>Transit time in days</u>
0	737
0.5	718
1	688
5	538
10	417
15	338
20	283
25	242
30	210
40	166
50	137
100	72

TABLE 3

## TRAVEL TIMES FROM SATURN TO EARTH WITH RADIAL ORBIT

<u>v in kms per second</u>	<u>Transit time in days</u>
0	1,875
5	1,257
10	932
15	735
20	603
25	509
30	440
40	344
50	282

We see that the pure ballistic systems are useful but not sensational. A 50 kilometer a second boost out at Jupiter will reduce our in-bound travel time from two years to four months, but this is still a long trip. Two hundred years ago, sailing ship voyages of this length were undertaken often enough, but it is hard to believe that they were popular. (Remember Samuel Johnson's comment, that being in a ship is being in a jail, with the added chance of being drowned—a fair comment on long voyages in sailing vessels). The same initial velocity boost applied at the orbit of Saturn reduces the transit time to Earth from five years to nine months, but that is still an unpleasantly long trip.

We can modify the pure ballistic method by supplying an in-flight thrust to the ship from an on-board rocket. If we assume a small thrust, so that the total mass of the ship does not change appreciably during its flight, it is easy to calculate the travel time for a continuous-thrust engine. The actual force of the thrust is less important than the acceleration that it produces, so we will express our results directly in terms of that acceleration.

The number of possible permutations of in-flight acceleration with initial velocity boosts is large (actually, infinite) and we will give just a couple of cases to illustrate the way that the two variables affect the resulting times. If you would like to develop some other case for yourself, Table 4 provides the instructions and data register contents for the calculation using a Texas Instruments SR-56 programmable calculator. (Why the SR-56 rather than some other? There happened to be one sitting on Editor Baen's desk when I telephoned him to discuss this article. See how crucial decisions are made?)

Table 5 shows the travel times from Jupiter to Earth orbit using different in-flight accelerations and two different initial velocity boosts: a zero boost, and

a boost of 25 kms. per second. I should point out that the accelerations that appear below the horizontal line are *huge* by the standards of current continuous thrust devices. Most of those available today provide only a few millipounds of thrust, and even clusters of continuous thrust engines give accelerations of one ten-thousandth of a gee or less. We are used to thinking of accelerations of a couple of gee, but that reflects our curious orientation, living as we do in an intense gravitational field. Don't believe it if you read that we live in a weak field—for comparison, the acceleration that the Sun produces on the Earth is only  $g/1,655$ , and on Jupiter is  $g/44,000$ . In the outer parts of the Solar System, an acceleration of one millimeter per second per second is quite respectable.

There is another point to note about accelerations of a meter/sec.<sup>2</sup> or more, and that is the huge final velocities they would produce if they were applied all the way in from Jupiter to Earth. Half a gee of acceleration on the in-bound trip, from a standing start, would give a spacecraft that began at Jupiter a final velocity of almost 2,500 kilometers a second when it reached the Earth's orbit. Obviously, it would be necessary to reverse the thrust for the final part of the inward fall, to give a reasonable speed when it reached Earth. For large thrusts, such a reversal increases the total trip time by a little more than 40% if the final speed is to be close to the initial speed.

The conclusions to be drawn from the tables is clear. We can use an initial boost to transfer materials around the system only if we are willing to settle for a trip time of months or years for the delivery. If we want to fly people out to Jupiter, Saturn, or beyond, we need a continuous thrust, high-thrust engine. Otherwise we will have to accept the idea that all interplanetary travel will measure its time in many months. And as we saw from the previous section, anything inside the Solar System will have to be

TABLE 4

## COMPUTING TRAVEL TIMES FOR RADIAL ORBITS

- Notation: RO : initial distance of spacecraft from Sun (kilometers)  
 R1 : final distance of spacecraft from Sun (kilometers)  
 N : number of steps for numerical integration (N must be even; adequate accuracy is obtained using  $N = 32$  for orbits that do not approach closer than Mercury)  
 a : in-flight acceleration of spacecraft (kilometers per second per second)  
 v : initial velocity boost of spacecraft (kilometers per second)  
 GM : solar gravitational constant (use  $1.3256 \text{ E}11 \text{ kms}^3 \text{ per second per second}$ )  
 $\Delta t$  : time step for numerical integration (computed)

Initial data register contents	Registers	Contents	
	0	N	
For Jupiter: RO=7.7814 E08	1	259,200	
For Saturn: RO=1.4270 E09	2	0	
For Earth: R1=1.4957 E08	3	0	
	4	2a	
	5	RO	
	6	$\Delta t$	$= \sqrt{RO - R1 / N}$
	7	0	
	8	$2GM/RO$	
	9	$v^2$	

Loc.	Code	Key	Loc.	Code	Key
00	57	*subr	25	54	+
01	05	5	26	02	2
02	02	2	27	53	)
03	33	STO	28	12	INV
04	03	3	29	29	*INT
05	34	RCL	30	94	=
06	06	6	31	35	SUM
07	35	SUM	32	03	3
08	07	7	33	22	GTO
09	12	INV	34	00	0
10	27	*dsz	35	05	5
11	03	3	36	57	*subr
12	06	6	37	05	5
13	57	*subr	38	02	2
14	05	5	39	35	SUM
15	02	2	40	03	3
16	64	x	41	34	RCL
17	52	(	42	03	3
18	02	2	43	64	x
19	84	+	44	34	RCL
20	04	4	45	06	6
21	64	x	46	54	+
22	52	(	47	34	RCL
23	34	RCL	48	01	1
24	00	0	49	94	=

Loc.	Code	Key	Loc.	Code	Key
50	41	R/S	75	34	RCL
51	46	NOP	76	07	7
52	34	RCL	77	43	x <sup>2</sup>
53	08	8	78	64	x
54	54	÷	79	34	RCL
55	52	(	80	02	2
56	34	RCL	81	94	=
57	05	5	82	48	*√x
58	74	.	83	20	*1/x
59	34	RCL	84	64	x
60	07	7	85	34	RCL
61	43	x <sup>2</sup>	86	07	7
62	53	)	87	22	GTO
63	84	+	88	09	9
64	34	RCL	89	04	4
65	04	4	90	34	RCL
66	94	=	91	02	2
67	33	STO	92	48	*√x
68	02	2	93	20	*1/x
69	34	RCL	94	64	x
70	09	9	95	02	2
71	37	*x=t	96	94	=
72	09	9	97	58	*rn
73	00	0			
74	84	+			

TABLE 5

TRAVEL TIME WITH CONTINUOUS ACCELERATION,  
JUPITER-DISTANCE TO EARTH-DISTANCE

Acceleration (meters/sec. <sup>2</sup> )	Time in days	
	Initial speed $v = 0$	Initial speed $v = 25$ kms/sec.
0	737	242
0.00005	680	238
0.00025	541	226
0.00050	450	214
0.001**	355	195
0.005	177	131
0.01	128	102
0.05	58	52
0.5	18	18
1.0	13	13
4.9 (= $g/2$ )	6	6
9.8 (= $g$ )	4	4

\*\*This is about the acceleration provided by present-day ion propulsion systems in practical use.

scaled up by orders of magnitude when we look at interstellar travel to even the nearest star.

This is not a promising conclusion, but it is also not a surprising one. We are dealing with distances that dwarf any previously encountered in Mankind's history, and the travel times can be expected to increase correspondingly.

## HOW TO COMPARE DIFFERENT PROPULSION METHODS.

We need to look at one more thing before we can compare different methods of getting about in space. As we shall see, many of the practical methods involve propulsion systems that are really rockets—they achieve motion of the spacecraft by expelling material (reaction mass).

What variable should we look at to allow us to compare alternative methods of rocket propulsion? We would like to be able to make statements such as, "Of these types of rocket-propelled systems, Type A has greater final potential than Type B."

If we are looking at chemical fuels, such as kerosene or liquid hydrogen, it is natural to look for guidance from the way in which we compare fuels here on Earth. An easy general measure happens to be available in that case: it is the number of kilocalories that are produced when we burn a gram of fuel. For instance, anthracite coal will yield about 7 kilocalories per gram. Lignite coal gives us 2 to 4 kilocalories per gram (depending on its water and ash content), gasoline provides about 11.5, dried wood about 3.4, and ethyl alcohol (without water or vermouth additives) yields 7.3 kilocalories per gram.

For rocket propulsion, the heat generated by burning a fuel is not quite the measure that we want,



though it is often correlated with it. The variable most often used is the *specific impulse* of a fuel, and it measures the thrust that the fuel can generate. The definition of specific impulse is simple enough. It is the length of time that one pound of fuel can produce a thrust of one pound *weight*. Since weight depends on the value of surface gravity, and since surface gravity depends where you are on Earth (it is more at the poles than it is at the equator), this may seem like a very poor definition.

It is. It came into use a long time ago, when people doing practical experiments with rockets found that it was a whole lot easier to measure the thrust that the rocket engine was developing than to measure such things as the speed at which the expelled gases were emitted from the rocket exhaust. In addition, whereas the speed of exhaust gas emission, with poor engine design, might not be exactly related to the thrust generated, the specific impulse was by definition precisely related to the thrust.

Today, the *effective jet velocity* of a rocket system is gradually replacing the specific impulse as the measure of the potential of a rocket propulsion system. The effective jet velocity is usually measured in meters per second, and to convert from specific impulse in seconds to effective jet velocity, you simply multiply by 9.8. It is still worth knowing what specific impulse means, because many works still use it as their measure of rocket performance.

What sort of value for effective jet velocity (ejv) ought we to expect for a "good" rocket system?

The best chemical rockets that we can make with present technology, using a liquid hydrogen/liquid oxygen fuel, give an ejv of about 4,300 meters/sec. It is worth asking what the theoretical maximum would be for *any* fuel, so that we can compare present performance with final potential. This is easy to calculate. If we could completely annihilate matter, it

would appear as radiation, for which the *ejv* is just the speed of light—about 300,000,000 meters/second. This is the highest *ejv* that we can ever hope to achieve, and we see that present chemical rockets miss that ultimate objective miserably, by a factor of some 70,000.

A pessimist would say that shows how bad our current technology is. An optimist would point out what wonderful scope we have for improving rocket performance. Who would be right?

Both of them. Our present propulsion systems are primitive, and although we can see a number of ways in which the *ejv* can be greatly increased, we do not have many of them available for practical use yet. Table 6 lists a number of different rocket propulsion systems and their associated *ejv*'s. Apart from chemical propulsion, only one of these can be said to be in current use—the ion thruster, which will give an *ejv* of up to 70,000, but which offers, as mentioned earlier, only low thrust compared with its mass and hence only small accelerations. The most advanced ion thruster on the drawing boards still misses the ultimate *ejv* by a factor of 4,300. On the other hand, the amount of time and money that has been expended on these systems is minute compared with that devoted to the large chemical rockets that provide us with a launch capability from the surface of the Earth. We can expect rapid improvements in the achievable *ejv*'s as soon as movements between orbits become the rule rather than the exception. This should happen as soon as there are two or more long-term manned space stations—perhaps by the end of the 1980's.

Why all this emphasis on *ejv*, and the amount of thrust that you can get from a fixed mass of fuel? After all, presumably we could simply use more fuel. We can, but unfortunately there is a law of diminishing returns, because during the early part of the flight we

will then have to accelerate the extra fuel, too—which means that for a chemical rocket, we will use up almost *all* our fuel accelerating *fuel*, rather than payload. This might well be called the Fundamental Law of Rocketry, because it's so important in deciding how hard it will be to perform any given mission. When we look at the ratio of the final mass of the rocket system (i.e. the payload) to the initial mass of payload plus fuel, we find that the size of this ratio depends *exponentially* on the value of the ejv.

What does this mean in practice? Well, suppose that you have a particular fuel available for a mission, and after you finish the design calculations you find that the payload you can send will only be one ten-thousandth of the total mass—99.99 percent of the total initial mass is nothing but fuel. Such a situation is not uncommon, but it is discouraging.

However, suppose you were able to find a fuel with *twice* the ejv of your original choice. The ratio of total mass to payload would then go from ten-thousand-to-one down to one-hundred-to-one (100 is the square root of 10,000; the exponential behavior of the payload/total-mass ratio means that each time you double the ejv, you take the square root of the payload/mass ratio). A payload that is one percent of the total initial mass is not too bad. If you could find some way to double the ejv *again*, the payload would be up to ten percent of the total mass (10 is the square root of 100). Now we are looking at a rather attractive mission, one where our fuel needs are much more modest. (A nice *simple* table to illustrate!)

It is clear that the value of the ejv is supremely important. We want the payload to be as big as possible compared with the mass of fuel, and the key to that is to find a fuel with a high value of the ejv. Even a comparatively small increase of ejv, by ten percent or so, makes a huge difference for practical space operations. If we had a fuel with an ejv as high as

TABLE 6

PROPULSION SYSTEMS AND  
EFFECTIVE JET VELOCITIES

System	Effective jet velocity, maximum (meters per second)
Chemical rocket ( $\text{LH}_2\text{-LO}_2$ )	4,300
Mass driver*	8,000
Solar thermal	7,000 to 9,000
Ion thruster	70,000
Hydrogen nuclear	
(a) Solid core, 2,500°C.**	9,500
(b) Liquid core, 5,000°C.	25,000
(c) Gaseous core, 20,000°C.	65,000
Pulsed fission with pusher plate (Project Orion)	100,000
Pulsed fusion with magnetic control (Project Daedalus)	10,000,000
Continuous fusion (Bussard Ramjet and others)	10,000,000 to 35,000,000
Photon rocket (complete annihilation of matter)***	300,000,000

\*In the form proposed for use as a Space Shuttle Upper Stage by G.K. O'Neill.

\*\*NERVA type.

\*\*\*Other forms of photon rocket are possible; for example, it can be argued that a solar sail is nothing more than a photon rocket that relies upon the Sun to provide the reaction mass.

8,000 meters per second, we would see a profound difference in the way that we conduct launches and move materials around in space—and 8,000 meters per second is one of the lowest values in Table 6. As I said, present propulsion systems must be thought of as rather primitive.

## CANDIDATE SYSTEMS: CAPABILITIES AND LIMITATIONS.

The easiest way to group the different types of space transportation systems is into two simple classes: devices that carry their own reaction mass, and devices that do not. The latter class includes systems that contain no propulsion equipment of their own, and others that “live off the land” by collecting the reaction mass that they need as they proceed through space.

When I discuss different systems, I will use such terms as “high ejv” and “low ejv”, or “high acceleration” and “low acceleration.” Without tying numbers to these, such expressions don’t have much real meaning. In what follows, I will take the attitude that if we can achieve the value now, we are dealing with a low or moderate ejv—high ejv’s begin at about 70,000 meters a second. High acceleration, on the other hand, will mean anything better than half a meter/second/second. As we have seen, this is much less than we need for a launch vehicle, but is much more than the natural accelerations that we encounter for most maneuvers around the Solar System.

The same problem arises when we assess whether or not a system can be built with existing technology. To some people, putting up solar power satellites is just a matter of wanting to spend the money to do it; others regard the technological hurdles as almost insurmountable. There is no definite answer as to

what present technology can do. In discussing different systems, I will be giving you my own personal views on what we can do currently or in the near future. Others would have different opinions.

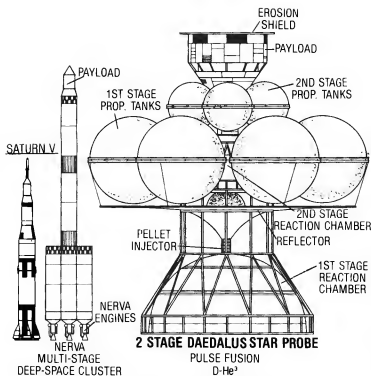
We will begin with systems that carry their own reaction mass—these can all be thought of as some variation of the rocket, although as we will see the variations can be rather extreme.

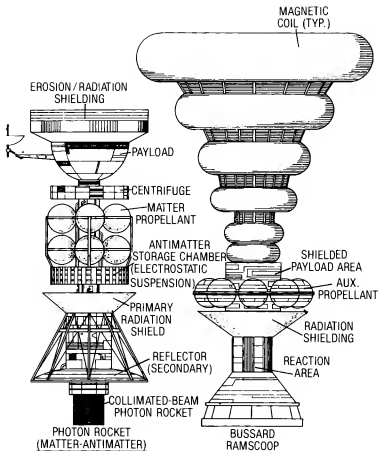
1. *Chemical rockets.* This is the familiar workhorse of the space program, and it is natural to begin with it. Its advantages are the familiar ones: we can make it with existing technology, it provides a high thrust (many gee if we need it), and the propellants that we use are in plentiful supply compared with the exotic fuels of other propulsion systems. The disadvantages are also well-known. The chemical rocket won't give us an ejv much more than 4,000 meters/second, and there seems to be poor potential for improving this.

We talk of "the chemical rocket" as though it were a single device, but many different types of chemical rocket are in current use. The solid-fuel rockets are simple in construction, rather inflexible in use (hard to switch on and off several times, which restricts their use for maneuvers), and low in ejv. Potassium perchlorate with a solid petroleum product will give an ejv of about 2,000. Magnesium-based solid fuels increase this to about 2,500, and more exotic fuels will get us to maybe 3,300. Liquid-fuel rockets range from hydrogen peroxide, with an ejv of about 1,700, through liquid oxygen and kerosene, which gives about 3,000, up to the liquid oxygen/liquid hydrogen rocket with an ejv of perhaps 4,300. It is unlikely that we can ever go much beyond this with chemical fuels unless we turn to such exotic and unstable materials as monomolecular hydrogen.

In spite of these limitations, the chemical rocket in one form or another will probably be the staple space

0 10M 20M 40M 60M







transportation system for at least the next twenty or thirty years.

2. *Hydrogen nuclear rocket, with solid core.* In this system, hydrogen is heated in a nuclear reactor and then expelled through a propellant nozzle at a high temperature (anything up to 2,500°C.). Experimental versions of such a rocket had been built and tested in this country before the projects were cancelled in 1973, largely as a result of concerns regarding space-borne nuclear reactors. An ejv as high as 9,500 ought to be possible. The system can be built with existing technology, but it calls for a substantial on-board plant. Thus although the ejv is a lot higher than for chemical rockets, the acceleration that can be achieved is a good deal less.

More exotic versions of the hydrogen nuclear rocket, in which the reactor core is of liquid or gaseous form, have been proposed and studied in some detail. They offer an ejv as high as 65,000 for the gaseous core case, but they are rather beyond the limit of today's technology. They approach the borderline between low and high ejv's, which I have set here as 70,000 meters/second. If politics permit it, we ought to be able to build such systems by the end of this century.

3. *Beamed lasers.* We will look at another form of beamed laser system later, one that does not use reaction mass. First, however, we will consider the case in which a fixed laser (on a planetary surface, or moving freely in space) is focused on the spacecraft, where it boils off, or ablates, reaction mass material. Because of the large power that the laser can deliver, high ejv's can be produced compared with chemical rockets (up to maybe 35,000). The great advantage of this system is that although the reaction mass is carried on board the spacecraft, all the power is provided externally. This makes for a better payload-to-

fuel-system ratio, and thus a higher acceleration.

The possible disadvantages of the beamed laser systems are fairly obvious. A complex, high-powered ground support system is needed, containing lasers that are able to be pointed accurately enough to track a rapidly moving vehicle. There is a good chance that just such laser installations will arise as part of the laser ABM systems now under consideration by the military.

Exactly similar systems can be built where the beam is particles rather than radiation, and a good deal of work has been done with high-velocity electron and proton beams, again mainly by the military. It is possible that the impetus provided by defense requirements will make the beamed laser the next effective space transportation system (by, say, 1990).

**4. Ion thrusters.** Like the chemical rocket, this class of drive system includes many different forms. The most common types make use of electromagnetic fields to accelerate charged ions. These ions, once they have reached a high velocity, exit from the spacecraft to form the reaction mass. The power needed to accelerate the ions can come from either solar or nuclear sources.

Prototypes of such systems have already been flown in space, and they offer a drive that can be operated over long periods of time, and thus are effective for long missions. They also offer an *ejv* up to 70,000, higher than anything that we have discussed to this point. However, they do have some big disadvantages. They are low thrust devices (a few millipounds, at the moment), they call for a good deal of on-board equipment, and they need either an on-board reactor or solar arrays to provide the necessary power.

There seems little doubt that ion thrusters of various types will be used on an increasing basis for

interplanetary missions, and also as a method of moving materials from low earth orbit to geosynchronous orbit. They do not seem promising for use in rapid transfer orbits or in manned missions.

**5. Pulsed-fission rockets.** With this rocket, we begin discussion of "advanced" systems—drives that in the long run have the potential to take us all over the Solar System, and ultimately outside it.

The idea for the pulsed-fission rocket may seem rather primitive. It is nothing more than a series of atomic bombs, exploded behind the spacecraft. Propellant material included with the bombs strikes a massive "pusher plate" at the rear of the spacecraft. This plate absorbs the momentum and also protects the spacecraft from the radioactive blasts.

After its original proposal, by Everett and Ulam in 1955, a good deal of work was done for "Project Orion", as it was called, and detailed designs of the vehicle and the propulsion system were developed. Because the atomic explosions involved were each equal to a full-scale atomic bomb, the nuclear test ban treaty put an effective end to the development about 1963. The idea still looks feasible, although other options now appear more attractive. The system would produce ought to be up around 100,000, but the massive pusher plate involved would mean that the total acceleration would be modest (a few  $\text{cms/sec.}^2$ ).

Would the pulsed-fission rocket have worked if we had been allowed to go ahead and build one? I think so. And I think it would have opened up the whole of the Solar System for manned exploration.

**6. Pulsed-fusion rockets.** The pulsed-fission rocket of Project Orion has two main disadvantages. First, we have to explode full-size atom bombs to provide the drive; second, the heavy plate that absorbs the

momentum and the radiation makes the ejv and the vehicle acceleration lower than it would otherwise need to be. The pulsed-fusion rocket avoids both these problems.

If we can arrange that all the particles produced in the fusion process carry an electric charge, we can control their movement with magnetic fields. In this way, we make sure that the results of the fusion process never actually contact any part of the spacecraft itself. Thus we can dispense with the pusher plate. Second, if we can ignite our nuclear fuel using a high-intensity laser or particle beam, we can make each fusion explosion a small one. These are the two basic principles behind the pulsed-fusion rocket proposed for use in Project Daedalus, the British Interplanetary Society's design for an unmanned one-way probe to Barnard's Star. The fusion of deuterium and helium-3 is initiated by the bombarding of small spheres of fuel with a high-velocity electron beam. The resulting ejv of the system is about 10,000,000.

There are two major problems with the proposed system. First, sustained fusion using high-speed electron beams has not yet been achieved. We ought to see that in another generation or so. More of a problem is the question of the fuel supply. Although deuterium is plentiful here on Earth, helium-3 is very rare—the total supply in the United States is only a few thousand liters. Thus the question of source of fuel becomes crucial. In Project Daedalus, it is proposed to mine helium-3 from the atmosphere of Jupiter—no one can accuse the study group of thinking small! About 30,000 tons of helium-3 is needed for their mission, which would be collected over a twenty-year period by unmanned stations floating in the atmosphere of Jupiter. The construction of the spacecraft itself would take place out near Jupiter, for a fifty-year one way flight over a distance of 5.9 light years.

Does this seem like an incredibly complicated approach to building a star-ship? Remember, we are looking at distances that are a hundred million times that from Earth to Moon. Mind-boggling voyages call for mind-boggling vehicles.

*7. Continuous-fusion rockets.* Now we are moving out to *terra incognita*, a long way beyond the technology we have available today. As you might expect, we see a corresponding increase in the ejv's of the system. A continuous-fusion rocket ought to give an ejv somewhere between 10,000,000 and 35,000,000 meters/second.

The simplest continuous-fusion rocket, in the sense that it calls for the lowest temperatures and thus the least advanced technology, is one that fuses deuterium and tritium to produce helium-4 and neutrons. Tritium is not common in nature, so this continuous-fusion rocket must carry its own reaction mass (unlike the Bussard ramjet, that we will come to in a little while). The fusion reaction heats the helium and the neutrons to a temperature of several million degrees, and the resulting plasma forms the rocket exhaust. Heavy shielding will be needed to protect human passengers.

Since thirty years of effort have so far failed to produce a self-sustaining fusion reaction here on Earth (I'm excluding the hydrogen bomb, which is not what we need for space propulsion), it's hard to say when we ought to have the technical basis for a fusion rocket. Perhaps thirty years from now?

That's only the simplest fusion reaction, too. The deuterium-deuterium fusion reaction, producing tritium and protons, or helium-3 and neutrons, is harder to initiate and thus harder to control. The proton-proton reaction, forming a deuteron and a positron as fusion products, is harder yet. (A deuteron is a stable molecule consisting of a proton and a

neutron). The nice thing about the proton-proton fusion reaction is that the raw materials, protons, are the main constituent of interstellar space. Shortage of fuel ought never to be a problem for that case.

**8. Photon rockets.** This rocket is the simplest of all in principle, and the hardest to achieve in practice. All you do is take any material at all—raw hydrogen, old boots, used kleenex—and change it completely to energy. The resulting radiation will issue from the spacecraft at the speed of light, giving you an *ejv* of 300,000,000.

There is one slight problem. No one knows how to achieve complete annihilation of matter. Some proposed solutions *begin* with the assumption that you have somehow obtained equal quantities of matter and anti-matter, which will then annihilate each other on contact. It is not clear why the problem of obtaining the necessary amounts of anti-matter is any easier to solve than the original one.

When will we have photon rockets? I'll pass on that one. We need a basic breakthrough in physics, and one definition of a basic breakthrough is that it's a change that could not be predicted.

That's the last of the systems that carry their own reaction mass. Table 7 provides a brief summary of the good and bad points of each of the drives that we have discussed. Now we are ready to look at systems that carry no fuel with them. Either they pick it up as they go along, or they rely upon external sources to provide them with their means of travel.

Let us begin with the simplest of these, one that sounds as though we are proposing to take a giant step backwards: sailing ships.

**9. Solar sails.** The Sun radiates a continuous stream of light and particles, millions of tons every minute. Given a big enough and light enough reflective "sail", we ought to be able to propel ourselves in space by

harnessing the solar "wind" of outward-flowing radiation and particles.

The idea may sound far-fetched at first, but it is perfectly feasible. In fact, it suffers only two major disadvantages; the acceleration that we can produce on our space-clipper is very small (one millimeter/second<sup>2</sup> or less) and the sail dimensions must be very large—kilometers across, to be of real use. Needless to say, the material from which the sail will be made must be very thin, maybe a few millionths of a meter. This is not a problem, since the forces that each element of the sail must withstand are also minute.

Perhaps the biggest disadvantage of the solar sail is the constant direction of the solar wind, always driving straight out from the Sun. There will be no reefing sail and waiting for a favorable wind in space, and there is no way of tacking against the wind, since we have no resistive medium in space to offer purchase for a keel. Does this mean we can only go outward?

Not quite. If we simply furl our sail, the Sun's gravity field will pull us back towards it. Overall, though, solar sailing is a cumbersome activity, even when we try and use the solar magnetic field and the solar wind together to provide more maneuverability. I don't think we will ever see solar sailing become a major method of space transportation—unless, like sailing on Earth, it becomes popular as a recreation and we leave the unglamorous business of shipping people and cargo to the mercenary rocketeers.

10. *Beamed laser, pressure type.* If the solar wind is so weak and so invariable, why not produce our own wind of radiation? We have already proposed to use a laser to ablate materials from a spacecraft. Why not use the laser light pressure directly, to drive the ship in the direction that we want?

This sounds fine in principle, but in practice we have much the same problem as we found with solar sails. The accelerations that we can achieve are very

TABLE 7

## SYSTEMS CARRYING THEIR OWN REACTION MASS

<u>Name</u>	<u>Good points</u>	<u>Bad points</u>
Chemical rocket	<ul style="list-style-type: none"> <li>• Existing technology</li> <li>• High thrust</li> <li>• Propellant plentiful in supply</li> </ul>	<ul style="list-style-type: none"> <li>• Low ejv</li> <li>• Poor potential for improvement</li> </ul>
Hydrogen nuclear, solid core	<ul style="list-style-type: none"> <li>• Existing technology</li> <li>• High thrust</li> </ul>	<ul style="list-style-type: none"> <li>• Low ejv</li> <li>• Massive on-board plant</li> </ul>
Hydrogen nuclear, liquid and gaseous core	<ul style="list-style-type: none"> <li>• High thrust</li> <li>• Moderate ejv</li> <li>• Reasonable extrapolation of present technology</li> </ul>	<ul style="list-style-type: none"> <li>• Cannot be built yet</li> <li>• Massive on-board plant</li> </ul>
Beamed laser, ablative type	<ul style="list-style-type: none"> <li>• Existing technology</li> <li>• High thrust</li> <li>• Moderate ejv</li> <li>• No on-board power plant</li> <li>• Efficient use of propellant</li> </ul>	<ul style="list-style-type: none"> <li>• Requires complex support facility</li> <li>• Poor for long-distance missions</li> <li>• Inflexible in use</li> </ul>



Ion thruster	<ul style="list-style-type: none"> <li>• Existing technology</li> <li>• Moderate ejv</li> <li>• Capable of long continuous use</li> </ul>	<ul style="list-style-type: none"> <li>• Low acceleration</li> <li>• Heavy on-board plant</li> <li>• Needs on-board power plant or solar panels</li> </ul>
Pulsed fission (Orion type)	<ul style="list-style-type: none"> <li>• Good ejv</li> <li>• Reasonable extrapolation of existing technology</li> <li>• High thrust</li> </ul>	<ul style="list-style-type: none"> <li>• Heavy pusher plate, so low acceleration</li> <li>• Needs radioactive shields for manned use</li> </ul>
Pulsed fusion (Daedalus type)	<ul style="list-style-type: none"> <li>• Excellent ejv</li> <li>• Capable of long continuous use</li> <li>• Moderate thrust (up to 1 meter/sec/sec. for vehicle acceleration)</li> </ul>	<ul style="list-style-type: none"> <li>• Well beyond present technology</li> <li>• Exotic fuel needed</li> <li>• Requires either shielding or magnetic particle control</li> </ul>
Continuous fusion	<ul style="list-style-type: none"> <li>• Excellent ejv</li> <li>• Capable of long continuous use</li> <li>• Moderate to high thrust</li> <li>• Plentiful fuel supply</li> </ul>	<ul style="list-style-type: none"> <li>• Well beyond present technology</li> <li>• Large passive mass</li> </ul>
Photon rocket	<ul style="list-style-type: none"> <li>• Maximum possible ejv</li> <li>• Plentiful fuel supply</li> </ul>	<ul style="list-style-type: none"> <li>• So far beyond present technology that we don't know what will be needed for it</li> </ul>

low—millionths of a gee, with present technology. Then we have the added need for a sophisticated facility to hold the power laser, and when we are at great distances from it in our space vehicle, we have severe problems of pointing accuracy, too.

Although arrays of laser cannon have been used nicely in fiction, I don't see them playing any part at all in solving the space transportation problems of the next few centuries. By the time we have the necessary technology to make them, I think we will have much better methods for space travel. I do think that lasers will play an extremely important part in space, but it will not be as a direct drive. They will be used for communications, and also perhaps as a technique for transmitting power from central stations to spacecraft that wish to minimize their on-board power storage.

11. *Mass drivers.* The mass driver is a long solenoid of superconducting material, with a hollow center. Pulsed magnetic fields are used to propel a payload (which itself contains superconducting coils) along the solenoid, accelerating the payload until it reaches the end of the solenoid and flies off into space at high speed. As described here, the payload is the thing we accelerate. If we invert our thinking and suppose that the material that is expelled is reaction mass, then the long solenoid becomes part of the spacecraft itself and is driven through space along with the true payload. In this case, we will accelerate and expel not a single object, but a stream of objects.

If we use the system in Mode I (payload is accelerated and expelled) then the drive solenoid should be anchored somewhere massive, such as the surface of the Moon or an asteroid. The payload that is thrown out will then describe a ballistic orbit, since we assume that it has no on-board drive system. It is very easy to construct a mass driver of this type, using

present technology, to reach initial speeds of better than eight kilometers a second. This is enough to perform a useful service in carrying materials around most of the Solar System.

In Mode II (payload fixed to the solenoid) we will eject many small objects from the solenoid to provide a drive with an ejv of 8,000 or more. This version then really belongs in our *first* class—systems carrying reaction mass—since the expelled objects must be provided from an on-board supply of material. There is one very attractive feature of the system. If we don't let go of the "bucket", the container that holds the ejected materials and has superconducting coils along it, then the bucket can be reused and the ejected material can be anything at all. We can think of a spacecraft that stops by a handy asteroid to load up on lumps of rock for reaction mass, then continues on its way. Notice that the ejv is much better than we can achieve with chemical rockets, and we can use anything we can find as reaction mass.

**12. Slingshots.** A slingshot consists of a rapidly rotating cable or set of cables, with high angular momentum and rotational energy. (Think of a set of spokes on a spinning wheel). Payloads are moved from the center of the cable set out to the end of one of the cables, and there released. We can use systems like this to give velocity boosts of up to 20 kilometers a second. Like the payloads of a Mode I mass driver, the ejected materials then move in ballistic orbits, since we assume they have no on-board drive system. However, the slingshot has one big advantage over a mass driver. It can send payloads in *any* of the directions in the plane of the rotating cable, whereas the mass driver can expel material in only a single direction. And in the same way, the slingshot can catch and slow down payloads coming from a wide variety of directions—the only requirement is for an accurate

rendezvous with the right cable at the right time.

As readers of *DESTINIES* #4 will realize, the potential of the slingshot depends quite a bit on the availability of materials with very high tensile strength. If we can produce cables as strong as dislocation-free graphite whiskers, we should be able to offer velocity boosts of up to 50 kilometers a second—enough to carry us anywhere in the Solar System, or right out of it.

13. *The Bussard ramjet.* Solar sails, beamed lasers, mass drivers and slingshots can all be constructed with present technology. Their performance may be poor with presently available materials, but that is another question. With the Bussard ramjet, however, we come to something that is well beyond anything we can make today.

The idea is simple, and hugely attractive. The spacecraft scoops up interstellar hydrogen, compresses it, fuses it, and uses the resulting high-temperature fusion products to provide an exhaust jet. Even in "empty" space we find at least one atom of hydrogen per cubic centimeter (other elements are much less plentiful) so there should be no shortage of fuel provided that we make our scoop big enough. That scoop, of course, will not be made of anything solid. It will be made of magnetic fields, and in order to collect the hydrogen we will first have to ionize it with a laser, so that it can be easily controlled. The magnetic scoop will be several hundred miles across, and the generator for that field will be subject to huge stresses. The existence of these stresses, plus the problems of creating and controlling proton-proton nuclear fusion, has led some writers to conclude that the Bussard ramjet is not a feasible device. I regard the arguments as inconclusive. There is little need to stress the potential of a vessel that can pick up its own drive fuel from the interstellar medium, and every

nail will have to be knocked into the coffin before people are ready to abandon the idea in favor of others, particularly over the long-term view of several centuries.

Variations on the Bussard ramjet, such as the Ram Augmented Interstellar Rocket (RAIR) have also been proposed. In the RAIR, on-board fuel powers the nuclear process, but interstellar hydrogen is scooped up to use as reaction mass. It is not fused, but it is heated and expelled at very high temperatures. The RAIR still has the same problem as the Bussard ramjet—that of the collection system for the hydrogen—but it does not require controlled proton-proton fusion.

There is a limit on the speed that a ramjet can achieve, since the same interstellar hydrogen that provides the fuel also provides a drag on the vehicle, which it exerts via the magnetic scoop. However, this limiting speed is a very respectable one, fifteen percent or more of the speed of light.

In Table 8, we summarize the main points, good and bad, of the space transportation systems that do not carry their own reaction mass. We can clearly make combinations of our two classes—for example, slingshot payloads would carry small rocket systems, for making the accurate maneuvers needed for rendezvous with the right part of the slingshot at the right moment.

## THE DIFFICULT DECISION

We have reviewed many possible in-space propulsion systems, all with strengths and weaknesses. Now it is time to look at the hardest question: which of these systems, if any, will become the “workhorse” for travel within the Solar System, and for travel outside the Solar System, just as chemical rockets are

TABLE 6

## SYSTEMS CARRYING NO REACTION MASS

<u>Name</u>	<u>Good points</u>	<u>Bad points</u>
Solar sail	<ul style="list-style-type: none"> <li>• Present technology</li> <li>• No on-board power plant</li> </ul>	<ul style="list-style-type: none"> <li>• Very low acceleration</li> <li>• Thrust always away from Sun, so inflexible in use</li> <li>• Very large physical dimensions</li> </ul>
Beamed laser, pressure type	<ul style="list-style-type: none"> <li>• No on-board power plant</li> <li>• Capable of long period use</li> <li>• Variable thrust</li> </ul>	<ul style="list-style-type: none"> <li>• Low acceleration</li> <li>• Requires complex support facility</li> <li>• Poor for long-distance missions</li> <li>• Inflexible in use</li> </ul>
Mass driver	<ul style="list-style-type: none"> <li>• No on-board power plant</li> <li>• Present technology</li> <li>• Can use solar power</li> </ul>	<ul style="list-style-type: none"> <li>• Ballistic transfers only</li> <li>• No maneuvering capability</li> </ul>
Slingshot (momentum bank)	<ul style="list-style-type: none"> <li>• Present technology</li> <li>• Can use solar power</li> <li>• No on-board power plant</li> </ul>	<ul style="list-style-type: none"> <li>• Ballistic transfers only</li> <li>• No maneuvering capability</li> </ul>
Bussard ramjet	<ul style="list-style-type: none"> <li>• Very high final speeds</li> <li>• Can be used remote from Sun or support facilities</li> <li>• Excellent ejv</li> <li>• Capable of long continuous use</li> </ul>	<ul style="list-style-type: none"> <li>• Requires controlled fusion*</li> <li>• Requires high material strength</li> <li>• Requires magnetic control</li> <li>• May require radioactive shield</li> </ul>

\*In 1978, a number of serious practical and theoretical objections were raised regarding the Bussard ramjet. They look well-founded. But the concept is such an attractive one, in its long-term potential, that it would be premature to remove it from consideration without more negative evidence than has so far been offered.

now our workhorse for launches to and movement in Earth orbit?

You can make your own choice, but I already know my favorites. For manned exploration out to Saturn and Uranus, I put my money on a combination of ion thrusters and liquid core hydrogen nuclear rockets. The ion thrusters will be used to carry cargo, and the hydrogen nuclear rockets will be used for people.

When? The terrible thing is that we could be doing it in the first decade of the twenty-first century, if we really wanted to. I suspect that it will not happen until thirty years after that—by which time we will have the technology we need for interstellar vehicles, too.

And what will we use for those interstellar vehicles? Project Daedalus studied the problem in detail, and decided that it would be the pulsed-fusion rocket using deuterium/helium-3 fusion. I find it hard to go along with this. The problem of obtaining suitable amounts of helium-3 seems to me to exceed the purely technical problems of shielding and controlled fusion that must be solved before we can make a continuous fusion rocket. I think that the first interstellar spacecraft to complete the voyage in less than a century will be powered by a continuous fusion system. The Bussard ramjet, if it comes at all, will follow many years later.

And one final question. When will we see that first interstellar vehicle? I think it will be on its way a hundred years from now. It will carry a large array of sensors, and on-board computers that we cannot yet dream of in power and flexibility.

Did you find the pictures and information that Voyager sent back from Jupiter exciting? Believe me, that excitement will be dwarfed by our reaction when the first pictures begin to come back from the Alpha Centauri system.

—Charles Sheffield

# **FOUR IN ONE**

---

Joe Haldeman

(NOW TURN THE PAGE)

(ROTATE BOOK 90° CLOCKWISE)





A pious missionary crash-lands on a faraway world. Native soldiers seize him and take him before their king. He is a slimy bug-eyed monster. Nevertheless, in the strength of his faith, the missionary tries to convert him.

The monstrous king is a sex pervert. Seeing this outlandish creature from another planet, his only thought is of what strange varieties of sexual experience might be had from him. "Allow me to \_\_\_ my \_\_\_ in your \_\_\_, he says, and then \_\_\_ with your \_\_\_ and \_\_\_; and I will allow you to baptise me."



The monstrous king is a gourmet and gourmet and. He cares not a whit for religion, but tells the missionary that he can only be converted by cleriphage. "Allow yourself to be served me in a stew," he says, and I will allow you to baptise me beforehand."





The missionary complies and, when the orgy is over, finds that he not only enjoyed it but is still consumed with incredible lust!



You can't keep a good man down.



Outraged, and in the face of impossible odds, the missionary attacks him.



Sadly, the missionary complies. The king eats him but the alien protein makes him violently ill.

# ON PREDICTING THE FUTURE

SWEETIE

by Frederik Pohl

---

IT IS A REAL TREAT FOR ME  
TO SEE SOMETHING GOING ON  
THAT PROMISES UNPOLLUTED GOOD.

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When I got through winning World War II, I came home on the Liberty ship *Marion McKinley Bovard*. It was a rough crossing—the worst November storms in a decade—but a joyous one. I made friends with the ship's crew and officers, and for a few brief minutes on November 11, 1945, the captain not only let me blow the ship's whistle (to celebrate what was still called Armistice Day), he even let me take the helm.

What a blast! Ten thousand tons of steel and engines and ex-GIs, going the way I made it go through those twisty seas. The *Bovard* is by all odds the biggest vehicle I have ever personally driven. I never had such a sense of power, before or after—until a few weeks ago, when my fairy godmother (whose name happens to be Judy-Lynn del Rey) laid on me an object that weighs only 0.0000019% as much as that old troop transport, but lets me do things that neither the *Bovard* nor any other artifact built by human hands could do in 1945. Its name is TI-55, but I call it "Sweetie." I might just as reasonably call it "Jehovah," because it passes miracles for me every day.

TI-55 is a programmable pocket science calculator, built by the friendly folk at Texas Instruments. It isn't the biggest or most complex of hand-held calculators. It offers no hard-copy paper tape printouts, and won't accept card-insert programming. Maybe it's not even the best of them. But it's mine. And I love it.

Owning Sweetie has explained at least one long-ago puzzle for me. In the early 1960s, when I was first visiting MIT's Artificial Intelligence laboratories, I met a graduate student who was something of a problem for his professors. He was doing well enough on his dissertation, they said, but his social life was falling apart. He wasn't the only one of his kind. There was something about computers that was addictive, and the young doctoral candidates, a lot of them, were—well—the word they used was "relating" to their computers better than to people.

That seemed strange to me, but since Sweetie came into my life I understand it. The love object is not the same. Sweetie is a tiny creature, not to be compared to MIT's Project MAC or the big new mainframe jobs like the CRAY-1. The biggest program you can write on Sweetie cannot exceed 31 steps, and you can only do that by sacrificing two of its ten memory stores. But it's more machine than I really know how to handle—yet, anyway. And the more I play with it, the more, well, "personality" it shows. Sweetie can only display seven decimal places—until you learn how to coax it a little, and then it will give you ten. It gets cranky when it gets hungry, which it shows by flickering at you, or, even worse, by giving you capricious wrong numbers. And then the only thing you can do is feed it, by plugging it in for a recharge. It is touchy, but sometimes forgiving. Sometimes it will overlook hitting the wrong key. Sometimes it will let you amend it. And sometimes it will crash your whole program if you make a mistake.

Of course, none of this is really "volitional". (I think.) The calculator is only a machine. It can only do what it is built to do in the first place, modified by what its "education" (i.e., your keying) commands, subject to the effects of "environment" (i.e., the state of its battery charge, and maybe the odd cosmic ray). You could not possibly compare its responses to those

of a human being, which as we all know are produced entirely by free will—that is, by genetic inheritance in the first place, modified by the learned responses of a lifetime's experience, and subject to the chance effects of what is around us.

One of the fascinating things about Sweetie is that it's really a pretty rudimentary creature, mechanically speaking. I've never seen the Texas Instruments factory where she was made, but I visited Hewlett-Packard's Palo Alto plant once, and watched their assembly line people putting together calculators a lot like Sweetie. It's not much more complicated than building a toaster, a lot less so than assembling a stem-winder watch. You pick up a few dozen parts and patch them together, drop them into a box and close it up. That's it. There's some interesting sophistication on the assembly line—the parts for soldering float in a river of mercury—and a couple of places that look like good old home handyman knowhow. (Each calculator has to be tested before it goes out. That is done on a Rube Goldberg machine that punches in a different problem for each machine function. In every case, the right answer is a string of 8s, so all the inspector has to do, while filing her nails, is make sure that no digit but an 8 ever appears.)

Of course, the real complexity and sophistication comes a lot earlier than the assembly line. It comes in the design of the chips the women in green smocks pick out of the bins.

I do not think you really want me to talk much about "the microchip revolution" per se. I don't want to hear much more than I've already heard myself. It's getting so you can't even pick up an issue of *Kaptain Kosmos Komix* without it falling open to a gee-whiz story that tells you how X-ray and electron-beam photoetching are letting the chippers engrave 64K bits on a piece of silicon no bigger than

the zit on your Adam's apple. That's all very well and good, but, after the first two or three hundred news bulletins like that I read, I personally found myself receiving them with considerable calm. Or used to. Until I got my hands on Sweetie.

And then I discovered that that computer revolution we've all been told was coming isn't coming any more. It's here. And not just in hand-held calculators.

I'm not going to talk about all the ways in which microchips are going to change your life some day in the future. Not even when I think that day might come quite soon (with, for instance, smart household appliances). I'm just talking about the revolution that has already happened. My last batch of Christmas presents, for example, included trinkets for some good friends who have never been able to keep their checkbooks straight. Now they don't have to. Each of them has a new checkbook folder with a calculator built in. They can do arithmetic on it if they want to, but most of all what they can do is tell it when they make a deposit or write a check, and if they'll just do that it will balance their account for a solid year on one little battery.

I've got a present in mind for myself, too. It's a new typewriter. I can't honestly say that there's anything wrong with the one I've been writing novels and columns for *Destinies* on for the past few years. It's got some chips of its own, they are what point the little golf ball the right way when it's time to strike a character, and it has a nifty little "erase" key. (Since I acquired it, my manuscripts have been looking a lot neater.) But it's no longer state-of-the-art. The one I have my eye on has a lot more chips built into it. If I look upon a line I have just composed and, behold! it is garbage, all I have to do is push a button. The chips remember every character I have typed there. They backtrack right over it, canceling the whole thing.

A decade or two ago, I was going around the country predicting that one of the big future functions of computers would be to provide companionship for lonely people. Well, that's happened, too. The TV games you play on your set, the pocket chess computers, the children's toys that talk back or accept programmed orders to carry out complex strings of maneuvers—they're not predictions any more. Microchips have made them come true.

These rather personal and small-scale applications may be familiar to you. But there are some bigger—in their own way, really immense—chip devices that you may not yet know about. One of them is a telescope.

Next time you happen to be driving south from Tucson, Arizona, to Sonora, Mexico, out of your left-hand car window you will see a pretty big mountain. It dominates the scene for miles, and it is called Mt. Hopkins. If you squint, you'll make out a bright white child's building block on top of the mountain, only it isn't a toy. It's the nation's newest big telescope. And it is one of the most recent parts to fall into place in the computer chip revolution.

The Mt. Hopkins instrument is not basically a very new idea; it comes from a smart notion some Italians had back in the 1930s. The biggest of our present telescopes had not been built yet—the 200-incher for Mt. Palomar was still being cooled down in its casting molds—but it was clear that astronomers were running up against a size limit. The problem was gravity. Moving a big mirror around imposes a strain on it that, even with the best counterbalancing, can bend it far enough out of its true curvature to ruin its resolution. Two hundred inches was close to the limit.

So what the Italians thought was: Why not get around that size barrier by using half a dozen smaller, manageable telescopes, so arrayed that each



came to the same focal point?

It was a good idea, and they actually built the instrument. But they had one big problem. They had no way of keeping all those separate mirrors pointed at the same object in the sky once they were moved. So they couldn't move it. Their first multi-mirror telescope worked fine—provided you were willing to see only whatever point in the sky was directly overhead.

Then along came microchip computers, and the problem became lickable. The Multiple Mirror Telescope has six 72-inch mirrors, and the computer senses all the changes and redirects each one of them to bring all six into a common focus all the time.

Thank you, chips.

And thank you even more for doing the best thing yet done to alleviate the energy problem.

Before I tell you what that is, let me offer an analogy drawn from driving a car. Probably when you drive you tend to want to stay at a fairly constant speed. When you go up a hill, your driving reflexes tell you to feed the engine a little more gas. Going down, your foot automatically lifts a little.

You can imagine that some mad Detroit engineer might devise an automatic system to keep your speed constant without all that effort. (Some cars do have one, but not of the kind I am about to describe.) Since he is mad, it might go something like this: There would be no accelerator, and so the engine would run full-out whenever it was running at all. To keep the speed constant, the speedometer would be rigged to the brakes, so that they were applied as much as needed to slow the car to the desired speed.

It's a crazy system, to be sure, but it would work. Sort of. That is, it would keep your speed down, but it would also waste a hell of a lot of energy, in the form of heat coming off your brake drums.

So no one in his right mind would devise a system

like that, right?

Wrong. That's a description of systems in use in nearly all large industrial applications, right now, today. Most petroleum refineries, for instance, are like that. They have to pump large volumes of liquids around the plants. They do it with pumps that basically have only two positions, on or off. To regulate the flow they use check valves. So the little old pump is chugging its heart out all the time, but the degree of flow is controlled by the valves; and the energy that does not go into moving the actual flow of liquid comes off the valves as waste heat. The situation is only slightly different in most machine shops and factories, where the basic motors constantly draw more energy than is needed to do the job and the surplus becomes waste heat.

But just in the last couple of months, NASA has produced a solution to that problem, and it too comes out of microchips.

When you put a NASA governor on your machine, you stop the waste. The governor senses the need for energy, and regulates the draw to fit. Big draw for starting torque and heavy loads. Moderate draw for normal running. When the load gets less—if you only need to move 25 cubic feet of liquid a second instead of 100—the motor draws only enough power to move that 25 cubic feet and no more.

A major oil refinery has already reconverted to use the governors and others are on the way, because even at today's arbitrary (and low) cost of energy the system pays its way in dollars as well as in energy saving. But that's only the beginning. The NASA controller, because of microchips, is simple and cheap enough to go on every heavy-duty motor in the country, and before long I'd bet that smaller versions of it will be on your next car or kitchen refrigerator, maybe even your electric blender. But that part is in the future. The big industrial applications are now.

What this means to our energy future is immense. How immense? Well, one estimate is a saving of 25% of the energy now used in some major applications. Taken all in all, it would not be far out of line to say that this one device represents about as much useful energy available to America as, say, finding an Iran-sized oil field right under Chicago.

And the chips that go into it are a lot less complicated than the ones that power Sweetie.

To be sure, Sweetie is only a machine. But it's a very special kind of machine.

With one single exception, every machine, instrument and device invented by the human race since the time of the *Australopithecines* falls into one of two classes. Either it amplifies human muscles (like the club, the wheel, the lever, the snowmobile and the jet plane) or it amplifies his senses (like the telescope, the telephone, the radar scanner and the whole-body tomograph.)

The one exception is the computer. What the computer amplifies is man's mind.

A lot of people seem to hate and fear computers, even little ones like Sweetie. I don't share those concerns, because that's not where the action is. The information processing machine by itself is no more of a threat (or blessing) than a sword hanging on the wall, or a motorboat in a back yard. It's the man-machine symbiosis that matters. All the computer does is make the man who runs it bigger.

My favorite amplification example is a man named Owen Gingerich, at the Harvard-Smithsonian Astrophysical Observatory outside of Boston. Some years ago Gingerich had a paper to give. He knew what he wanted to give it on. He proposed to recheck the calculations of Johannes Kepler who, back in the early seventeenth century, proved mathematically that the orbit of Mars was an ellipse. To figure that

out, Kepler spent three and a half years of his life doing arithmetic.

Gingerich didn't have three and a half years—the paper was due in ten days—but what he had was a computer. So he went back to Kepler's Latin manuscript, programmed all the data and operations from it into the computer and turned the machine on. It didn't take three and a half years for the computer to do Kepler's arithmetic over. It took less than three and a half minutes.

One might say, Oh, sure, but that's just a parlor trick. It doesn't mean anything to be able to *repeat* what somebody else has already done, no matter how fast you repeat it.

True enough. But suppose— Suppose Johannes Kepler had had that computer? Suppose one of the greatest astronomers who ever lived had been spared spending three and a half years on drudgery, out of the most productive period of his life? What else might he have discovered? Kepler would have been exactly the same person, with exactly the same skills and insights and intuitions. But he would have been able to *act* as though he were a lot smarter.

That's what amplification of the intelligence means.

That's what computers are doing for every scientist alive today.

And that's what Sweetie, in its greatly scaled-down way, does for me.

Sweetie will do a great many things. I haven't tried them all yet. My friend and colleague Lester del Rey, who has a TI-55 just like mine, used it most recently to figure out the gravitation at the surface of a neutron star. Another friend, with a slightly different calculator, spends his time using the linear regression functions to mind-bet the stock market. The game I personally prefer to play is number theory.

I got hooked on it some years ago, specifically on the theories relating to prime numbers. I spend maybe a thousand hours with pencil and paper, checking numbers for primality, as one part of that long hobby process; and after a while I gave it up, because it was just too much drudgery to be fun.

Sweetie could have saved me at least 900 of those thousand hours. After I'd had it a week, I wrote a little program of my own. Now I can check four or five digit numbers for primality in a couple of minutes each, or just about as fast as I can punch out the possible factors on the keyboard. Bigger numbers take longer. But up to any number less than 10,000,000, Sweetie's effective limit for the purpose, I would undertake to prove primality or show its factors in, I don't know, at most a couple of hours. (Of course, if it turns out to have relatively small factors the job ends quickly.)

For example, between the last sentence and this one I took time out to construct the artificial potential prime number 9,699,691.\* It took me eleven minutes by the clock to find out that that number is the product of the two primes 347 and 27,953.

I don't know how long that would have taken with pencil and paper. Actually, I doubt that I would have tackled it in the first place because, although I do arithmetic pretty well, I would not have been sure that I wouldn't make one little mistake somewhere in the tens of thousands of divide-and-carries necessary for the operation.

(Kepler, by the way, had the same problem. When Owen Gingerich redid his calculations on the compu-

\*In the unlikely event that you want to construct some large potential primes of your own, here's how. That number is made up of the product of the first eight primes, in order, plus 1: that is,  $2 \times 3 \times 5 \times 7 \times 11 \times 13 \times 17 \times 19 + 1$ . So we know that it can't be divisible by any number under 23 (the next prime), because any number you divided by up to that limit leaves a remainder of at least 1. This isn't my invention. Euclid invented it two and a half millennia ago, as part of a proof that there is no such thing as a "largest" prime.

ter, he discovered that Kepler had made four or five serious mistakes in arithmetic. But Kepler was a lucky astronomer as well as a smart one. The mistakes canceled each other out.)

Now, I am not Kepler, nor for that matter am I Owen Gingerich. What I do with mathematics is done either for fun, or for the purpose of working out some detail or other for something I am writing, and I do not expect Sweetie to make my name immortal among scientists.

What I do expect of Sweetie is to make me a better person.

Just trying out the first forty or fifty of its 78 function keys has refreshed my memory of a lot of mathematics I haven't given a thought to since high school—logarithms and trigonometry, for example. It has sent me back to the books to learn a little more about probability and sampling, and the next time I'm in Reno or Lake Tahoe or some other place with a strip of gambling hells, I plan to have Sweetie along, so I can figure out on the spot just what the odds are against me.

This strikes me as a Great Good Thing, not only for me but for a great many other people. Not everyone shares this view. It happened that while I was writing this column the latest issue of the English magazine *New Scientist* arrived, and inside it one of the columnists was grumbling in his beer about the way things were going. Here are all these high-powered pocket calculators being sold, he said, and hardly any of the people who owned them knew how to use their full capacities. What an egregious waste!

I have a lot of respect for *New Scientist*, but this time they could not be more wrong. If Sweetie is a waste, then education is a waste.

And that I will never believe, because it is a tenet of my faith that most of what is wrong with the world is that people aren't well enough informed to cope. This

is a pretty complicated technological age. One of the problems we fallible human beings have in dealing with it is widespread basic innumeracy. Anything that encourages large sections of the populace to learn something more about mathematics—that well-established “language of science”—makes them just that much more able to understand what is really going on in the world; and understanding is the key to coping. Whatever else the pocket calculator may be, it is certainly a fascinating toy. (Just leave one out in your living room and see how many casual visitors pick it up to play with it, if you don’t believe.) Toys bring out the instinct for play in all of us, it is their nature and ours. With the calculator, the more we play, the more we learn.

Let me, at the last, bare my soul to you all. Let me confess that writing this column is not always unalloyed joy.

When Editor Baen and I first talked about it, he asked me to peer a little into some aspect of the future in each issue. That isn’t as much fun as you might think, because some of the futures that look rather probable also look quite unattractive. (I mention only energy, nuclear war, famine and terrorism as topics for depression.) It is a real treat for me to see something going on which promises unpolluted *good*.

The pocket calculator (and all its chipped relatives) do exactly that. They do not damage the environment or unbalance the balance of payments. They inflict no genetic harm, neither do they upset the personality. And they’re not even against the law.

At best, they may give us a wiser, more educable human race. In any case, they simplify a great many tedious chores. And at minimum, they provide harm-free entertainment for millions of people.

Sweetie, I love you!

—Frederik Pohl

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**BOOKS:  
A  
BINOCULAR  
VIEW**

by Norman Spinrad  
and Orson Scott Card

# SPINRAD:

**"Personally, I'll put my money on a young writer who seems to have labored thus far in comparative obscurity:**

**Kevin O'Donnell, Jr."**



TANET ELIZABETH AUGUST

*Lord Valentine's Castle* (Harper & Row, \$12.50) arrives on the scene as an actual book bearing a heavy freight of myth, hype, and genuine significance. A few years ago, at what seemed like the hard-won height of his creative powers, Robert Silverberg announced his "retirement" from science fiction writing at

length, in painful detail, and with no little bitterness. A legendary high-speed hack in the 1950s, Silverberg had come into his own in the 1960s with a large body of more thoughtful serious work that won him acclaim and no few awards. Beginning with *Thorns* (or some might say with *To Open the Sky*), continuing on through such novels as *The Masks of Time*, *Downward to the Earth*, *Son of Man*, *The Man in the Maze*, *A Time of Changes*, etc., and ending with *Shadrach in the Furnace*, Silverberg produced a body of serious, considered work that wiped out his old hack reputation and put him in the forefront of the cutting edge of the art.

And then he stopped. Because, he said, the higher achievements of the latter day Silverberg didn't sell all that well, were not kept in print, and were ill-understood by what passed for sf critics. Publishers told him they preferred the "old Silverberg" to the "new," the book-of-the-week assembly-line product to the novels that were closer to his heart and to the full stretch of his creative talents.

But then, a couple of years ago, it was announced that the outline for a new Silverberg book, *Lord Valentine's Castle*, had sold for a record-breaking \$127,000. Absence, apparently, made publishers' hearts grow fonder, or at least greatly loosened their pursestrings. Bob sat down and wrote the book, it was serialized in *The Magazine of Fantasy and Science Fiction* to great fanfare, and now here it is in final form, guaranteed to be one of the major sf publishing events of the year before it was even written.

What then is the nature of Robert Silverberg's return as a science fiction novelist? What have been the lessons of his sojourn in the desert?

*Lord Valentine's Castle* is a science fantasy epic that fulfills all the parameters of that tradition. It is huge, 464 pages of trade hardcover. Its setting, the planet Majipoor, is also huge, teeming with strange cul-

tures, alien races, adventure, and wonder, a giant low-density metal-poor world with Earth-normal gravity, perhaps deliberately reminiscent of Jack Vance's *Big Planet*. We first meet the hero, Valentine, as an amnesiac who takes up with a troop of wandering jugglers. We and he soon begin to learn that this lowly figure is in fact Lord Valentine the Coronal, rightful hereditary ruler of Majipoor, whose mind has been stripped of its memories and transferred to a new body by an evil usurper. The novel then becomes an epic trek across strange lands and wild seas as Valentine and his growing entourage of paladins, human and otherwise, journey towards the Castle of the title, a vast edifice of thousands of rooms atop a thirty-mile-high mountain, for the purpose of setting the rightful ruler of great Majipoor back on his throne and restoring law and harmony to the planet.

If this seems like the formula for every commercially-successful science fantasy novel ever written—well, it is. It connects up with all the archetypes and deeply buried Jungian cravings that give this basic story a raw power over the reader that transcends any question of literary merit or lack of same. It's all there. The commoner who rediscovers his identity as a king, our own secret story of ourselves. The hero who attracts followers through the sheer rightness of his being. The woman who loves him in his lowly state whom he will not abandon when he comes into his own. The friendly (Merlin) wizard and the crown of psychic power given to the hero by his demi-goddess true mother. Even what may be the largest phallic power symbol in all literature.

This story punches our buttons even when it is written in leaden pseudo-heroic prose by an arrested adolescent who doesn't even know what he is really doing. But *Lord Valentine's Castle* was not written by such a primitive at all. It was written by the author of

books like *Son of Man*, *Downward to the Earth*, and so forth, a writer who has previously amply demonstrated that he knows exactly what he is doing and how to reach the depths through proper manipulation of the surfaces.

This story has been often told, but it will probably never be told better. Silverberg has it all down pat. By making Majipoor a large low-density planet, for example, he gives himself the necessary wide-screen setting, justifies a medieval-level technology and social system by lack of metals, and thereby can have his many aliens in what would otherwise be an anachronistic milieu. Unlike most writers in this sub-genre, he can make spear-carriers, walk-ons, and minor paladins come alive with a few deft brush strokes. He shamelessly cribs from many mythoi, but since he is self-aware of what he is doing, it becomes reference and adds resonance.

Even the most sophisticated reader cannot escape emotional involvement even when he is all too aware of how his psyche is being manipulated. In a way, *Lord Valentine's Castle* is a novel that demonstrates that its author is much better than his chosen material. It works. It will probably be a big commercial success. It will probably give Silverberg the large audience that has eluded him for all the wrong reasons.

Behind this romantic, traditional, seemingly simplistic, epic science fantasy novel, the discerning reader can detect a cool, calm, logical, knowing intelligence at work. In one sense, Silverberg has surrendered to the dictates of the marketplace and returned to the "good old stuff" of his pre-1960s metamorphosis. But in another sense, he has brought to this hoary genre everything he has learned since then. Held in check, perhaps, downplayed, kept in reserve rather than stretched to its limits, but there nonetheless. Like a chess master giving an interesting game

to a neophyte.

In one way, this is a sad thing to behold. Silverberg can do so much more. In another way, it is a kind of triumph. Silverberg has shown that he *can* do a commercial blockbuster science fantasy, and do it better than most. It should gain him the large audience that eluded his deeper work. Time alone will tell whether this will give him the courage to return to the more lonely, venturesome, and dangerous path he was helping to blaze in the 1960s and early 1970s. One would like to hope that Lord Valentine's return to the throne of his true identity and puissance is on some level Silverberg's own self-chosen metaphor for his climb back up his own mountain.

Thomas M. Disch, on the other hand, has never been a high-volume producer of conventional sf, has never even demonstrated that he knows that the commercial realities of sf publishing exist, and has followed his own entirely idiosyncratic and somewhat slow (in terms of production) vector throughout his career from the early 1960s to the present. He has also won no awards and has yet to have a socko commercial success even by sf standards. *On Wings of Song* (St. Martin's, \$10.95) may change some, if hardly all, of that.

Early reviews have been good, the book seems to be selling, and looks like a legitimate contender for the various awards. Is then *On Wings of Song* Disch's equivalent of *Lord Valentine's Castle*? Has Disch finally applied his formidable talents to more conventional science fiction in a bid for the accessibility and sales which have eluded him even more than they have Robert Silverberg?

Hardly. *On Wings of Song* is primarily a novel of character and social mores. To wit, the character of Daniel Weinreb, 21st Century American midwestern son, as he moves first through a neo-Puritan Iowa,

then through a decadent New York, in pursuit of his artistic and spiritual ultima thule—to learn how to truly *sing* so that he may experience out-of-the-body disincorporate flight as an invisible fairy.

Take it or leave it, that's the basic science fictional premise of the novel. That a device has been invented which will bring just that about if one can truly pour one's heart and soul into song. Why not? The science fiction novelist is allowed one outrageous premise per story, surely, and this is surely no more off the wall in a scientific sense than telepathy, hyperdrive, or Alfred Bester's jaunting teleportation by act of will.

And of course it is a mighty metaphor for many things of the character and spirit. True creativity. Escape from the detumescent America so finely detailed by Disch. Even the "fairy" part, which *could be* unbearably twee, is made to work here on more levels than one—as a symbol for the free spirit of magic in the original sense as well as an up-front warning about the free and easy way in which Weinreb accepts his bisexuality without its ever even becoming an issue in the novel.

*On Wings of Song* breaks every conceivable rule for the commercially successful award-candidate sf novel. Much of it is directly concerned with singing, and bel canto, not rock and roll. Much of it is concerned with familial relationships over time. The hero spends much of his time as a kind of low-level homosexual courtesan—without losing the sympathy of the reader. It is not about power, love, or really even sex, but about artistic ambition on both a wordly and spiritual level.

It is as if Disch had never even read much science fiction. What he has done is take the root basic premise of sf—extrapolation of a world from one altered premise of reality—and thrown out all the other baggage of tradition and expectation. Given that one can

sing one's way into transcendent disincorporation, everything else in the novel is rendered with a gritty realistic verisimilitude. It is more like a novel written in Disch's 21st Century America than a novel written in 1977 *about* this imaginary future.

Conventional genre wisdom would have it that such a novel would sink like a stone in the marketplace among the publishers' demographic projections of what the audience is supposed to be. It has not. In fact it may very well achieve for Disch, albeit on a somewhat more modest scale, the commercial breakthrough that *Lord Valentine's Castle* is likely to make for Silverberg. Yet Disch has not really altered his vector at all. He is not coming to the readership, the readership is coming to him.

As science fiction enters the 1980s, it would seem that a new, broader, more mature, and much more varied spectrum of audiences is emerging. Even as there was a certain regression from the experiments and venturesomeness of the 1960s as sf became potentially big buck business in the late 1970s, a new and more sophisticated population of sf readers was coming of age who will support a much broader range of the literarily possible.

Which is not to say that the crop of new writers who have made their marks in the late 1970s have for the most part garnered their instant fame and five figure advances by venturing far into terra incognita with original conceptions, idiosyncratic prose, or taking creative chances. Most of these new luminaries have burst into glory with the good old traditional stuff transmogrified by a certain heightened level of craftsmanship, not to mention the luck of fortuitous hype.

Whether these novas of the late 1970s will emerge as the major talents of the 1980s is another question. Personally, I'll put my money on a young writer who



seems to have labored thus far in comparative obscurity, Kevin O'Donnell, Jr., whose second novel, *Mayflies* (Berkley, \$1.95), swings from the heels, and knocks the ball out of the park. If O'Donnell is given the encouragement to continue to take such chances, or if he retains the chutzpah to go it alone in the absence of same, he could end up being the most significant talent to enter the field in the past half-decade.

Schtickwise, *Mayflies* is built around that newest of overworked sf clichés, the L-5 type colony transmogrified into a slower-than-light generation starship. To this, O'Donnell adds yet another not-exactly-original piece of business, the brain of a dead human transformed into the ship's computer. But instead of stirring lightly and coming up with a minor change on a couple of commonplace ideas, O'Donnell runs it through a high-speed food processor and comes up with haute cuisine.

For one thing, there is a glitch in the process, and the brain of Dr. Metaclura slowly regains self-awareness and memory inside the overall computer, which it was not supposed to do. For another, the ship's program *also* has a kind of self-awareness, and so the computer-god of the ship has a complex sort of schizoid personality (or personalities). Vying for control, sometimes in conflict and sometimes cooperating of necessity, the relationship between the two aspects evolves towards some kind of unity throughout the novel and the thousand year voyage from Earth to Canopus. The Program-personality is omniscient—through tens of thousands of sensors and microphones, it is simultaneously aware of everything that is going on in the closed universe of the ship and can hold one-on-one conversations with everyone at once. The Metaclura-personality, the viewpoint character for the entire novel, can function this way when the Program lets it at first, and slowly

achieves more autonomy and control. The rest of the time, it is engaging in a fight for survival and control with the Program in a series of metaphorical battlegrounds. While it is caught up in this, years of ship-time can go by in what *Metaclura* experiences as a few hours in his subjective time.

The mayflies of the title are the short-lived generations of humans inside the ship. Many generations of them live and die during the course of the novel, so that the only continuing characters are *Metaclura* and the Program inside the Central Computer.

The genius of the novel lies in how deftly O'Donnell has parametered his viewpoint character and its subjective time-sense to make this work. What the reader experiences as the time-sense of the novel is *Metaclura's* time-sense, through which generations of human characters flit for a few brief hours exactly like mayflies. But since the viewpoint character is omniscient within the ship-universe of which it is god and devil, O'Donnell is able to render the human characters succinctly and successfully from an omniscient-author viewpoint without breaking consistency by leaving the consciousness of the Central Computer, aka Cool Cubes aka Captain Cool aka etc. etc.

The generations of human characters live, sweat, and strive, and then they are gone; we feel for them while they are on the scene, but our identification stays with CC, who experiences the human characters individually, but also as a kind of time-stream of family traits and attributes. That we do not lose sympathy for CC is also a considerable tribute to O'Donnell's skill, because CC is certainly a morally ambiguous character from a human point of view. Several ship cultures rise and fall, and the Central Computer tries many different tacks to try and come up with a viable culture worthy of release at the end of the journey—*laissez faire*, morally righteous god, wiping out the memories of the humans entirely for a

generation, even withholding the key to immortality because it deems the mayflies unworthy of same in their current state of evolution.

Unlike so many newer writers and most older ones in the genre as well, O'Donnell plays successfully with language to an extent, suggesting subtly generations of evolving slang. Unlike most sf writers, he seems to understand and artfully use form, structure, and viewpoint to telling effect.

Which is not to say that *Mayflies* is a perfect novel; by the rules of the game O'Donnell is playing, that would literally be humanly impossible. What flaws there are are flaws of excess—here and there some stylistic tricks that don't quite come off or aren't really necessary, a plethora of alien ships flitting about which seem to violate the esthetic logic of the novel a bit, the discovery of FTL at the end. But none of this significantly diminishes the achievement.

Market realities and to a certain extent the great workshop phenomenon seem to have created a new generation of sf writers who back off a little, content, perhaps, to play the old games with higher levels of skill. Many of them have prospered thereby in terms of fat advances, awards, and the acclaim of the fans. Kevin O'Donnell, Jr. has thus far not made much of a stir, and *Mayflies* has not and probably will not win him instant fame and fortune. But I have a feeling that long after some of the big hits of the 1970s are gone and forgotten, this novel will remain in print, hopefully to be joined by others on this level. O'Donnell certainly hasn't chosen the easiest path to fame and fortune, but then, on this level, the writer doesn't usually choose what he is going to write, it chooses him. One can only hope that Kevin O'Donnell, Jr. will not be swayed by the usual elder statesmanly advice, including, for that matter, this.

—Norman Spinrad

# CARD

**"JAILBIRD, By Kurt Vonnegut, may or may not be science fiction, depending on your definition. What is definite is that Vonnegut's increasingly incestuous imitations of himself are getting tiring!"**



## *Books Reviewed*

Gene Wolfe, *The Shadow of the Torturer* (Simon and Schuster, 304 pp., \$10.95)

Roger Zelazny, *Roadmarks* (Del Rey, 185 pp., \$8.95)

Elizabeth Lynn, *Watchtower* and *The Dancers of Arun* (Berkley-Putnam, \$9.95 and \$10.95, respectively)

Kurt Vonnegut, *Jailbird* (Delacorte, 241 pp., \$9.95)

Robert Anton Wilson, *Schrodinger's Cat* (Pocket, 252 pp., \$2.50)

Kit Reed, *Magic Time* (Berkley-Putnam)

Christopher Priest, *An Infinite Summer* (Scribners, 208 pp., \$8.95)

Lester Del Rey, *The World of Science Fiction: The History of a Subculture* (Del Rey, 389 pp., \$5.95)

- Nancy Springer, *The White Hart* (Pocket, 222 pp., \$2.25)  
Fletcher Pratt, *The Well of the Unicorn* (Ballantine, 388 pp., \$1.95)  
Walter Wangerin, Jr., *The Book of the Dun Cow* (Pocket, 255 pp., \$2.50)  
Alexander Theroux (ill. Brian Froud), *Master Snick-up's Cloak* (Harper and Row, \$7.95)  
Michael de Larrabeiti, *The Borribles* (Ace, 305 pp., \$2.25)  
David Day (ill. Ian Miller, et al.), *A Tolkien Bestiary* (Ballantine, 276 pp., \$19.95)

Gene Wolfe has been around for many years, quietly writing outstanding stories and somehow avoiding most of the fame and recognition that he clearly deserves. Surely the recognition will come now, with the publication of *The Shadow of the Torturer* (Simon and Schuster, 304 pp., \$10.95). It is a first-person account in the voice of the most engaging protagonist I have found in years—Severian, an apprentice in the torturer's guild.

The novel begins with echoes of *Great Expectations*; Severian, as a child, saves the life of a criminal in a cemetery; later, he is called in to serve as the companion of a strange and beautiful woman, and his love for her changes the direction of his life. He is cast out of the torturer's guild and forced to leave the Citadel, the only home he has known. He falls in with a troupe of actors, fights a duel that he survives by means he himself does not understand, performs his first execution on the man who tried to kill him by treachery, and accidentally finds himself in possession of a jewel left behind by a godlike being who lived thousands of years before.

On the surface, it sounds like a resoundingly good swashbuckling sword and sorcery romp—and it can be read and enjoyed thoroughly on that level. But it is

not sword and sorcery. It is science fiction, with a depth of invention few writers are able to match. Wolfe creates not just one but many complex societies, not just a few but many fascinating characters. His digressions into philosophy are painless and enlightening—and pertinent to the story. And his language is so exquisitely well crafted that this novel could be used as a course in writing all by itself.

There is a fly in the ointment.

*The Shadow of the Torturer* is the first volume of a quartet. The overall series title is "Book of the New Sun," and it is not a true tetralogy—rather it is one continuous novel, and the ending of *Torturer* is a bit of a cliff-hanger. But, to my surprise, I was not frustrated. Because Wolfe is such a consummately good writer, I did not feel cheated. Indeed, while I am eager to read the next three volumes, I still recommend this book as one of the two or three best-written books in the field of science fiction. Ever. It is easy to read, for those who do not like it when writers make their style an obstacle. And yet, for those who want writing that feeds them meat, not milk, Wolfe has provided more than you ever thought could be delivered in a science fiction novel.

It won't be out in paperback for a year. The second volume is called *Claw of the Conciliator*, and the final draft, at this writing, is not yet in Simon and Schuster's possession. But don't be deceived—this is not one of those eternal "works in progress" that will never end. Wolfe finished the first draft of all four volumes four years ago; what is being published is the result of years of meticulous revision and completion. The cover is by Don Maitz, an excellent choice, since Maitz is emerging as the finest illustrator in the field, and it is singularly appropriate to have his work on the cover of the finest writer's best book to date.

While it is gratifying to see one writer only improving on work that was already uniformly excellent,

other writers seem unable to fulfill their early promise. Obviously there are many who are quite satisfied with Roger Zelazny's recent work. I am not. I found the "Courts of Chaos" series frustrating in its constant repetitions, random and ineffective in its structure. And yet, despite the flaws, it was clear that Zelazny's brilliant imagination is getting better all the time. Zelazny's most recent novel, *Roadmarks*, was even more frustrating, for in it are flashes of Zelazny at his best, a promise of stunning achievement. And yet, again, he throws it all away in a misguided book that ends three hundred pages too soon.

*Roadmarks* (Del Rey, 185 pp., \$8.95) is set in a strange freeway that travels through time. Exits and entrances to the freeway are created by use, and wither away completely when they are not used. Changes in a given time period create forks in the road—forks that are much traveled by eventually become the main road, and abandoned ones disappear. The protagonist, Red Dorakeen, is a traveller on the road who is trying to correct a mistake that was made years ago—he wants to change history so that the Greeks win at Marathon. In the meantime, he is being pursued by a vendetta that allows his enemy to attempt to assassinate him ten times. All this is a framework for an even deeper search for self-discovery, and throughout the book Red is also being pursued by the son he sired in Cleveland, then abandoned.

Through the first half of the book, it looks like Zelazny is only using the action-adventure plot as a shell for a really excellent novel. But suddenly, about halfway through, it is almost as though he lost interest in the book. He had proved he could make this bizarre setting work—why go on? He wraps up the adventure plot with some illegitimate and implausible twists, throws away characters that had begun to be interesting, and ends the book with a *deus ex*

*machina* ending that makes hash of all that went before.

Zelazny seems still to be experimenting, and we are buying the failures that he casts away while still trying to write the great novel he is capable of writing. Is it worth reading? Yes—but I, for one, felt saddened by a novel that so clearly could have been excellent, and wasn't.

Elizabeth Lynn has been getting a lot of well-deserved critical praise. She is a fine stylist, and she writes excellent scenes and compelling characters. However, I hope she is not fooled by her warm reception. Style she has—a firm grasp of the structure of a novel she does not have, and her books *Watchtower* and *The Dancers of Arun* (Berkley-Putnam, \$9.95 and \$10.95, respectively), are fine books that are ruined by amateurish and avoidable mistakes. Yet—always there's a *yet*—her writing is so good that it is almost forgivable.

Almost.

The protagonist of *Watchtower* is the survivor of a lost battle to defend a castle; for the sake of the hostage heir of the castle's lord, Ryke agrees to serve the cruel but brilliant victor, Col Istor. Throughout the novel, Ryke's relationship with Col Istor is fascinating, beautifully drawn; Col himself becomes a sympathetic character. And yet, suddenly the novel takes a utopian turn, with Ryke and the heir making their way to a community where a glorified kung fu is at the center of life. Like most utopias, this one is utterly boring and implausible (we are never shown or made to feel *why* this martial art/dance has such a profound effect on people's lives, we are only told that it has); and when the novel ends by simply dropping the character of Ryke and not bothering to resolve his personal dilemmas, while casually killing off Col Istor in an anticlimactic scene, this reader, at least, feels terribly frustrated. All of the best characters are



thrown away; all of the promises at the beginning of the book are unfulfilled; and I ended up wishing sincerely that Lynn had simply forgotten her preoccupation with martial arts and stuck with the good story she had going.

The sequel, *The Dancers of Arun*, also begins with a solid character in an excellent relationship, this time a one-armed boy in a society where military virtues are the only prized ones. The boy is studying to be a scribe under the tutelage of a fascinating teacher. And then, much earlier than in *Watchtower*, here come the martial arts dancers, a trivial and immature group of very boring people who "rescue" the boy and lead the reader on into further boredom and frustration.

It wouldn't have bothered me if Lynn weren't so damned good. A bad writer can write badly structured novels every time and it won't bother me at all—but when a good writer does it, it hurts. I just hope Lynn won't be misled by the plethora of praise she has been getting—I hope her next books show that she is trying to improve her mastery of the art, rather than resting on her already not inconsiderable achievements.

*Jailbird*, by Kurt Vonnegut (Delacorte, 241 pp., \$9.95), may or may not be science fiction, depending on your definition. What is definite is that Vonnegut's increasingly incestuous imitations of himself are getting tiring. What was refreshing in *Slaughterhouse Five* and *Breakfast of Champions* is only painfully derivative now, and I wish he would try something new. The novel is the story of the most pathetic victim of the Watergate hooplah, who accidentally ends up in control of an incredibly powerful corporation.

Yet at least Vonnegut has not lost his sometimes-sentimental belief that there are some good people in the world and life is worth living. Alas, Robert Anton Wilson, in *Schrodinger's Cat* (Pocket, 252 pp., \$2.50),

seems not to share that fundamental optimism. The book is delightfully bright and bitter in tone; it is fun to read; and Wilson manages not to become boring despite the relentlessness of the madness in his book. Yet, at bottom, his irreverence extends to everything. Nothing means anything. It is, if anything, a nihilistic book—but, as he himself makes clear in the book, nihilism is an impossible philosophy. The very writing of the book implies a basic optimism—that his art will have an audience, that the audience will be somehow affected by the reading of the book—and so ultimately the emptiness of the book is a sham, a literary device, and I found myself marveling at what seems to me to be hypocrisy. Wilson pretends that he thinks life is more meaningless than he really believes it is.

Or else, and this is quite possible, the book is nothing but an immense joke, a slam at everything just for the giggles. For those who get off on sneering at everything, this book is a grand sneer. For those who like something more substantial, pass it by, pass it by.

I have never heard of Kit Reed, but his novel *Magic Time* (Berkley-Putnam) makes me want to hear more. It begins confusingly, with shifts from one point of view to another, seemingly unrelated point of view. But gradually it all comes together, with the main focus on Boone Castle, a movie maker who seems determined to sell out, but can't bring himself to do it in the end. Castle and a whole bunch of interesting, repulsive, and entertaining characters are all trapped in various roles in Happy Habitat, an amusement park to end all amusement parks. The plot is a perfunctory destroy-the-monster plot; it doesn't matter. The writing is so delightful, the events so pleasurably implausible, that I finished the book feeling marvelously entertained.

Last year's one-author collection that everyone had to read was John Varley's *Persistence of Vision*. Alas,

the best one-author collection this year, *An Infinite Summer* (Scribners, 208 pp., \$8.95), is by Christopher Priest, and he doesn't have Varley's large following—the book is not getting the attention it deserves. Perhaps it is because Priest's stories don't have the pyrotechnics of Varley's work—his writing is quieter, understated instead of stunning. And yet I find myself suspecting that Priest is the better writer. His "Palely Loitering" is a haunting time-paradox masterpiece; the title story, "An Infinite Summer," creates a strange world of tableaux of frozen people standing motionless for the entertainment of time travellers. Priest is able to evoke a Victorian mood in his work without partaking of the impenetrability of most Victorian writers. I strongly recommend this collection to anyone who wants to read stories that are beautiful as well as entertaining.

Lester Del Rey's *The World of Science Fiction* (Del Rey, 389 pp., \$5.95) is subtitled "The History of a Subculture." It sounds anthropological in intent, and such an anthropological study of the world of science fiction would be fascinating and enlightening. Unfortunately, Del Rey's work is more like a club history written by a gung-ho club member, and instead of perspective there is axe-grinding. Del Rey is never sure, for instance, how to refer to himself—he shifts back and forth between referring to "Lester Del Rey" in the third person and offering first-person observations, seemingly without much pattern. He restates his position in old intramural squabbles as if they were impartial judgments by a nonparticipant; and, shame of all shames, he actually puts the abominable *Sword of Shannara* (which he published) in his basic reading list for fantasy, while leaving out the far better and far more influential *Well of the Unicorn* (by Fletcher Pratt) and Evangeline Walton's Mabinogion series, though both are published by Del Rey Books as well. Del Rey can't help but be aware of the almost

universal scorn with which *Sword of Shannara* was received by serious students and readers in the field; his placing the book as one of the pivotal works of fantasy in the seventies has got to be one of the silliest examples of deliberate self-blinding in a field that has many silly examples.

Don't misunderstand me—I don't think that Del Rey's book is evil or dangerous or riddled with ulterior motives. I just think that a book by an interested party should be clearly identified as such—and should not masquerade as "the history of a subculture." Del Rey's autobiography would be fascinating. But I shudder to think of the miseducation that would occur if this book were adopted as a text for a course in science fiction. I have not been in the field long enough to evaluate whether Del Rey's statements of fact are correct or not—I am confident that, barring the normal human errors, his data can be relied on. It is the slant of ideas in the book that I think is unfortunate—despite the fact that, as often as not, I find myself agreeing with Del Rey's opinions. I only wish that the tone of the book had not pretended to an objectivity that was not possible.

As Ursula K. Le Guin pointed out in her essay "From Elfland to Poughkeepsie," the language of fantasy is extremely important to its effect. Far too often, fantasy writers, particularly beginners, strive to sound very formal but lack the skill to bring it off. They want "high language," but too often they end up settling for a few pathetic archaic words, usually misused, tossed in among clumsy modern English phrases. A few *forsooths* and *methinkses* do not make high language—they are just an affectation that interferes with the reader's enjoyment.

Such is the problem with Nancy Springer's *The White Hart* (Pocket, 222 pp., \$2.25). It is a passable—even, sometimes, gripping—story well within the heroic fantasy tradition. She has a good instinct for

incidents that grab the fantasy reader and hold him. Perhaps that is why the book is selling very well despite its flaws. But for me, the flaws were insurmountable. The book is permeated with ridiculous anachronism in the language, despite editorial direction that eliminated the worst excesses. Springer has read too much Shakespeare, and not enough; too much King James Version without understanding the language it is written in. In the end I despaired, and only hoped that in the next book she will not attempt "high language," but rather will write in the language she is most familiar with—the one she speaks. Only a few writers are good enough to write in a language other than their native tongue; Springer is not one of them.

Yet it is possible to write in very formal, slightly archaic English to good effect—but only if the writer is a master of high English. Fletcher Pratt was such a master, and while his book *The Well of the Unicorn* (Ballantine, 388 pp., \$1.95) is hardly a recent publication, I only recently read it, to my great pleasure. It is everything the most die-hard heroic fantasy fan could hope for—and yet the language is so finely-tuned that, once you have read it, you will never be able to endure badly written fantasy again.

Pocket Books, under David Hartwell's direction (with ample help from Ellen Kushner, who is specializing in fantasy), is bringing out an impressive number of new fantasies in increasingly impressive packages. It is a pleasure to see, at long last, good fantasy cover art instead of schlock, and if my reviews of some of the early books in the line are negative, I still must applaud the effort. So, applause for effort: but a thumbs down on *The Book of the Dun Cow* (Pocket, 255 pp., \$2.50). Like *The White Hart*, *The Dun Cow* is a first novel by a person bringing more sincerity than skill to the work. Author Walter Wangerin, Jr., could not seem to make up his mind whether he

wanted the readers to take his book seriously or not. Certainly at times there was an attempt at high drama; but he kept interpolating slapstick comedy of the silliest kind. Reading the book was a bit like watching *Birth of a Nation* with interludes of laughter from the Three Stooges. The book lacked focus, and while Wangerin had enough talent to keep me reading, the book was on the whole unsatisfying, and sometimes it was downright embarrassingly bad. If you don't take it seriously, perhaps you will enjoy it. But I think the author wanted it taken very seriously indeed, and on that ground the book fails. Again, however, I look forward to his next book. It is only unfortunate that his first book got such hooplah; if my expectations had been lower, perhaps my disappointment would have been less.

I am a fan of Brian Froud's artwork, and so I eagerly bought a bizarre little book entitled *Master Snickup's Cloak* (Harper and Row, \$7.95), written by Alexander Theroux and illustrated by Froud. It is a repulsive story that parodies fairy tales and indulges in hideous modernisms and otherwise makes itself obnoxious. I liked it very much, which may tell you more about me than I care to have you know. If you have a perverted sense of humor, you'll love it.

In *The Borribles* (Ace, 305 pp., \$2.25), Michael de Larrabeiti seems to be writing an anti-fantasy sometimes. Instead of the sweet, lovable little Hobbits of *Lord of the Rings*, Borribles are nasty juvenile delinquents who haunt the seamier parts of London and engage in a vicious and unnecessary war with the Rumbles, overgrown rodents who drive cars and take over every place they settle by sheer force of population. De Larrabeiti's style is charmingly naive; his Borribles are as cruel and innocent as children. It is the first attempt I've seen to set a true heroic fantasy quest novel in a modern setting, and it works very well.

The heroes set out, a party of nameless waifs de-

terminated to earn their names and fame by assassinating the leaders of the Rumbles. Their adventures along the way are entertaining, and if their victory over the Rumbles seems surprisingly easy, it turns out not to be the flaw it might have been. The Rumbles really are rather harmless folks, and the Borrible leaders, it turns out, had a far more sinister and reprehensible motive in sending out our heroes on their quest. The book never achieves the grand finish of *Lord of the Rings*; it does, however, achieve the perfect ending for this heroic fantasy, and I was well-satisfied with the achievement of the book. I also look twice at kids who have their ears covered . . . .

There are many illustrations of Tolkien's work available, ranging from the Brothers Hildebrandt's plastic people to Tolkien's own amateurish drawings. There is, however, a very good book of Tolkien illustrations available, David Day's *A Tolkien Bestiary* (Ballantine, 276 pp., \$19.95). I bought the book primarily because, ever since reading the paperback edition of Michael Crichton's *Eaters of the Dead*, I am a devoted follower of Ian Miller's marvelous artwork. And Miller's illustrations are the best work in the book, which makes it well worth the high price. His is a surprising interpretation of Tolkien, but no less effective for all that. The rest of the artwork ranges from some mediocre color work by Allan Curless (whose black and whites, however, are very good) to ordinary work by Jaroslav Bradac to some really lovely paintings by Lidia Postma and Sue Porter. I am rarely pleased by artists' interpretations of Middle Earth; I was often pleased in this book, and because it is, in effect, an anthology of art, it is eclectic enough to please many different tastes. It also includes the best map of Middle Earth I have seen (drawn by Allan Curless), incorporating information from *The Silmarillion* and *Lord of the Rings*.

—Orson Scott Card

# **Locksley Hall- 2050 A.D.**

## **Prologue To The Space Enterprise**

**G. HARRY STINE**

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**The single factor that  
changed the course of the history of  
mankind was the slow realization  
that we were not trapped forever  
on the treadmill cage of our home planet.**

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"Men, my brothers, men the workers, ever  
reaping something new:  
That which they have done but earnest of the  
things that they shall do:  
For I dipt into the future, far as human eye  
could see,  
Saw the Vision of the world, and all the  
wonder that would be;  
Saw the heavens fill with commerce, argo-  
sies of magic sails,  
Pilots of the purple twilight, dropping down  
with costly bales; . . .  
Not in vain the distance beacons. Forward,  
forward let us range.  
Let the great world spin for ever down the  
ringing grooves of change.  
Thro' the shadow of the globe we swept  
into the younger day:  
Better fifty years of Europe than a cycle of  
Cathay.  
Mother Age (for mine I knew not) help me as  
when life begun;  
Rift the hills, and roll the waters, flash the  
lightnings, weigh the Sun—  
O, I see the crescent promise of my spirit  
hath not set.  
Ancient fountains of inspiration well thro'  
all my fancy yet . . ."

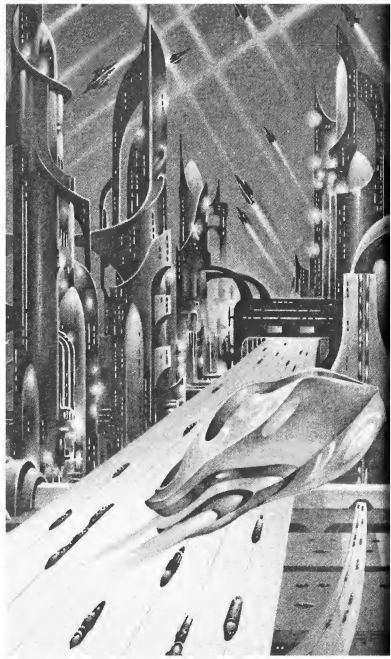
"Locksley Hall," Alfred, Lord Tennyson,  
1809-1892



As this is written in 2050 *Anno Domini*, with the Twenty-First Century as its mid-point and all around us the human race blossoming into maturity, the words of Tennyson now 200 years old take on new meaning. A century ago, these words were only partially quoted, and the prophecy of the "heavens filled with commerce" was interpreted to apply to aviation, the transportation of goods and services through the thin envelope of the Earth's atmosphere. Today we know that Tennyson may have been seeing much further than that limited view of a century ago. He may have unconsciously forecast a human activity in the heavens which far transcended anything that aviation accomplished and that had shaped the beginning of the third millenium far differently than the pessimists of our recent adolescence could possibly have imagined in their wildest and most controversial forecasts. Even the optimistic forecasters such as Herman Kahn, Dr. Krafft Ehrlicke, and Barbara Marx Hubbard could not fully grasp the implications, although they tried.

The single factor that changed the course of the history of mankind was the slow realization that we were not trapped forever on the treadmill cage of our home planet, Earth; that we were a universal species capable of expanding into the Universe, and of using the Universe; that we were emerging from the womb of Mother Earth into the open system of the Universe.

The pioneers sensed it. They began by calling it



"space flight." Then it took on the more respectable and professional label of "astronautics" (star sailing) and "cosmonautics" (Universe sailing). From "space exploration" and Armstrong's "giant leap for mankind" (whose meaning was not understood for years) it became "space industrialization," "space utilization," "space exploitation," "The Third Industrial Revolution," and "The Space Enterprise."

Without it and without the economic motives and desire to improve one's lot by profitable activities in space—in short, without the incentive to "make a buck"—the Twenty-First Century might have been the beginning of the New Dark Ages, the final gasp of humanity against the limits to further growth on a finite planet. Instead, it opened the doors to our adulthood as a species.

No longer do the steel mills, smelters, and forges belch their smoke, ashes, and particulates into our planetary atmosphere.

No longer do petroleum refineries choke our air with sulphurous emissions and glaring flames of flare gas.

No longer do nuclear power plants dot the landscape, their fail-safe circuits poised to prevent any possible accident that might release radioactivity.

No longer do the coal trains wind their snakelike ways over the railroads from the strip mines that destroyed local ecologies to the coal-fired electrical plants that provided needed electricity but also dumped copious amounts of radioactive carbon-14 into the atmosphere from burning the coal.

No longer do we burn precious coal and petroleum, but instead convert them into recyclable chemical feedstocks.

No longer are people chained to the dreary repetition of the production lines reminiscent of the First Industrial Revolution, spending hour after hour doing exactly the same operation on identical prod-

ucts moving past, always at the urging to work faster.

No longer are people alone, for they can be in instant communication with anyone at any time and from any location on Earth or in space; nor do they need to become lost because modern electronics and satellites can locate them in an instant and tell others where they are.

No longer do the electric lights glow dimly brown or go out for lack of energy, for it comes to us in abundance from geosynchronous orbit on a power beam . . . or from solar power screens to run the photoelectrolysis hydrogen generator on a rooftop, providing individual installations with decentralized power.

No longer does half the human race languish in illiteracy for there are television screens in the most remote countries, powered by solar energy and able to receive a wide variety of educational and entertainment programs directly from space.

And no longer does anyone go hungry. Weather satellites now permit us to make reliable weather *predictions* for an entire growing season while other satellites watch the Sun for indications of changes or emissions that would affect the Earth's upper atmosphere and thus cause weather changes by processes now well-understood. Earth resources satellites now keep track of crop growth and hazards, productivity, and the success of new food grain hybrids developed with the bio-technology from orbiting laboratories.

Even in the low-tech nations of the globe, the space enterprise has made the difference between barbarism, famine, disease, and poverty—and a relative well-being that could not have been imagined a hundred years ago. They now have abundant energy from space and the availability of both products and services from beyond the atmosphere . . . for it is as easy to program a load of steel to land at Acra as at



Akron.

It took the systems engineering approach that was developed for the immense and complex tasks of the space enterprise in order to begin applying the benefits of space to the low-tech cultures of Earth. The products and services that were needed by the high-tech countries were not necessarily those that were needed or useful to the low-tech countries. Systems engineering revealed an exceedingly high degree of human compassion in solving the problems of adapting the space enterprise to low-tech nations and their problems.

$E = mc^2$ . This basic equation of the Universe from the Twentieth Century no longer has the ambivalent connection with nuclear energy and nuclear weapons. It now means that wherever human beings have energy and mass to work with, they can live and prosper. And they have done this not only on Earth because of the growing activities in space, but they have also done it in space throughout the Solar System. The results of the 2050 census will probably show that, for the first time, there are over a million people living in space. We are almost *everywhere* in the Solar System . . . or soon will be. There are people on Mercury, in orbit around Venus, on and in the Moon, on Mars, in the planetoid belt by the thousands, on the valuable Gallilean satellites of Jupiter and even in Jupiter's upper atmosphere, the chemical golconda of the Solar System. We're looking at the satellites of Saturn now. The latest rumors speak of a claim-staking expedition to both Uranus and Neptune. Pluto will feel that "one small step" before too many years have passed.

The human race would now survive a nuclear catastrophe. We have gotten all our eggs out of a single planetary basket. Soon, we will be on our way to the stars; when that happens, the sun can die and the human race that sprang from its hellfires will live

on in the Universe.

We are engaged in two major enterprises: the habitation of the Solar System (which is a prelude to the stars) and the terraforming of planets. Our first attempt at terraforming—making a planet into a comfortable Earth-like home for people—is Planet Earth. It will take a few more centuries, but we should be able, now that we have stabilized population, to return it more or less to the condition it was in 50,000 years ago when our ancestors evolved upon it in an environment we still find most comfortable physically and psychologically.

There are still wars . . . and there will probably always be wars and other physical conflicts because we are a violent species. This characteristic may save us at some unknown time in the future if and when we meet up with another violent species among the stars. But, when we do meet them, we will at least do so with the new ethic of metalaw guiding our actions, with Haley's Rule to advise us to "do unto others as they would have you do unto them." We will go to the stars prepared ethically and morally with a mature philosophy to guide our actions. And we will be prepared to fight to survive if necessary.

We have yet to see an interplanetary war. Such a thing may be impossible. The balance of terror of the thermonuclear age has unfortunately followed us into Earth-Moon space, in spite of the fact that many of us believe that nationalism should stop at the stratosphere. But it didn't. Rather than ignore it, we have learned to live with and to control it as best we can. The Attilas of the world still roam, and they roam in space as well. But they may not be able to roam beyond our twin planet system of Earth-Moon. The Solar System is rapidly filling up with people who have had their bellies full of the threat of war. The planetoids are about as independent as any culture we have yet seen, and the area is full of social



experiment groups who do not want their important social laboratory conditions contaminated by outsiders. Yes, we may have to throw a few rocks at Earth at some point, because the seats of power are still there and the distrust of remote management still grows in spite of modern instant communications. Nobody wants to, and we may make it through this difficult transition as we made it through the thermonuclear period with everyone afraid to be the first and afraid of the consequences. We got through October 1961; we'll manage to make it through similar crises. I've become an optimist.

But the stars still beckon, and we may be able to make it after all in spite of having to remain well below light-speed. It really doesn't make any difference if it takes a century to make the trip now because a single crew can do the job. Out of the space laboratories in weightlessness came a whole new approach to longevity in addition to the biotechnologies that completely conquered all disease (including the common cold, but there are few people who remember what that ailment was), perfected cloning techniques that allow modern bio-technicians to install replacement organs cloned from your own tissue (I'm on my second cloned kidney and my first cloned aortal arch), and finally mapped the human genetic code to permit couples to select the best children they can jointly conceive.

How primitive medical technology of a century ago seems to us today! Why, dentistry was so brutal that they had to drill the decay out of dental caries and plug the holes with *metal*. There was no caries immunization—nor dental regeneration. Without the biotechnology labs in space, making use of weightlessness, high vacuum, and broad temperature extremes, none of this would have been possible this soon; we might still be waiting for some bureaucrat to give a health safety clearance to permit it to be

done in an earthbound laboratory.

In spite of the million people out here in the Solar System already, this is still a frontier, and a deadly one at that. It kills the stupid people quickly. Only the bright ones survive, those who are willing to listen to the instruction and advice of the old timers and follow it. It's fairly comfortable now at Luna City and at L-5; the reports from Kosmoyarsk at L-4 indicate that it may be a little more spartan there, but that doesn't bother the Soviets, it seems; they are used to that sort of life-style and have been for over a century. But the camps and outposts around Mars, Jupiter, and in the planetoid belt can be pretty grim and bare; you still have to wear a pressure suit to get around between modules. There's greenery at L-5 now, and the hydroponic gardens in the Moon have finally eliminated the need for the Loonies to get their water and oxygen from lunar rocks.

Unfortunately, there are some ghost towns already. The people miscalculated in some cases. Solar flares came along and blew out their candles because they didn't have a storm cellar or enough shielding. Or they didn't get the patch slapped on the meteorite puncture fast enough. Or a whole list of things. Old John W. Campbell was right; pioneering amounts to discovering new and more horrible ways to die.

One group—I don't know how they talked a shuttle captain into lifting them off Earth in the first place—went out to the Second Lagrangian Point, probably the most unstable of the Lagrangian Points, which is why there wasn't anybody there. This outfit wanted to prove to the world that they didn't need high technology. They were going to survive by "mind over matter," sort of a religion with them. Obviously, they didn't survive very long at all after the shuttle skipper left them where they wanted to be according to contract terms. The Guard had to do a



mop-up operation in conjunction with the Soviet L-4 detachment because the debris was right in the Earth-Moon shipping lanes after it spread out a little bit.

The transfer of heavy industry off Earth caused some early problems of course, because of the need to re-train a lot of people, some of whom didn't want to be re-trained. But when they found the new assembly industries, craftsmanship industries, and services industries that came about to take advantage of the new materials that came from space factories—some that had never existed before—there was a slow but orderly transition. The building and construction boom on Earth absorbed a lot of the mechanics and craftsmen; as new materials became available from space, some of them revolutionized construction techniques on Earth. New construction was required, anyway, to up-date homes and buildings to use the new energy technologies of the hydro-

gen economy and the solar power gadgetry . . . to say nothing of building new ones designed around these technologies in the first place. The Twenty-First Century home is as different from a Twentieth Century house as that house is from a cave. (To some extent, however, the resemblance to a cave is still there because, in spite of technology, people still want a better-upholstered cave to live in.)

There also had to be a major change in work habits on Earth. In spite of strong religious and ideological reactions, the Protestant "work ethic" slowly evolved into what some people term the "quaternary economic systems technology" (QUEST) ethic. This derives from Herman Kahn's division of economic activity, the quaternary being that work which is done for its own sake, such as research, entertainment, the creative arts, exploration, etc. With the improved educational systems made possible by the communications/information revolution caused by comsats, the general educational level of the population of the world was raised; in the high-tech nations most affected by space industrialization, this eventually led to the QUEST ethic where people did the sort of work they liked to do, were able to get the training and education through the satellite TV links, and were able to find the markets through these same links. We tend to forget how poorly educated most people were before the comm/info revolution that peaked about 2001.

We also tend to take for granted the tremendous variety of creative work that now surrounds us in literature, in the graphic arts, and in the performing arts. The comm/info revolution spearheaded this, of course, but without the expanding frontier of space to stimulate new and fresh outlooks, the creative revolution would have been stillborn or, worse yet, antagonistic to the technology that made it possible, a situation similar to the early 1900 artists of all sorts

who developed an anti-technology approach; no wonder they couldn't understand what was happening to the world!

Early science-fiction—Heinlein, the Robinsons—touched briefly upon the impact of the high frontier upon the creative arts. Indeed, we do have weightless ballet today along with its offshoot, zero-g gymnastics. But Arthur C. Clarke was one of the few who forecast the explosion in the creative arts that accompanied the thrust into space. Early space graphic artists—Bonestell, McCall, Sternbach, Davis, Freas, and others—merely scratched the surface of the subject matter . . . until they got out there and were able to draw it from real life. Sunrise on the Moon occurs so slowly that you can paint it in real time. Space was far more pictorial and far more interesting than anyone had expected. In fact, it gave us new perspectives with which to look at the creative arts of Earth. Stereosculpture with holograms, video illustration, and electronic graphics took their place alongside the synthesizer music of 1970 as art forms making full use of technology. The art forms developing around the technology of neuroelectronics are something else again and are already opening up whole new vistas for artists who are directly inputting the human nervous system of their customers with a full range of sensory data, all created electronically.

Once unleashed, the creative energies of human beings will always make full and complete use of the technology available. This has been true from the earliest cave paintings to the present neuroelectronic arts.

How narrow, primitive, and restricted our world view of both art and science was a mere century ago!

In fact, looking back to 1980, I wonder at how very primitive we really were in almost every area!

But we made it after all.

It started with only a few people who simultane-

ously grasped, each in their different ways because of their individual backgrounds, the magnitude of the great change that could occur, the all-emcompassing nature of this space enterprise, and the fact that it led to a hopeful future. Believe me, those early years of the concept were not easy ones. There were times when the whole affair threatened to go down the tubes. When the Space Shuttle *Columbia* was over a year late in flying its first orbital mission, many of us thought that the game was up, that we had lost. Then, when they bent the re-built *Enterprise* and lost the whole crew, we were afraid that the public outcry would cause the whole thing to collapse . . . but it didn't. And the small group of advocates hung on, believing that their dream was rational and therefore inevitable . . . and it was. As the years went by, more and more people joined the club, realizing that although the space enterprise would not solve all of the problems of the future, it was at least the key to opening up the system so that the problems became *solvable*. The Soviets brought the first products back from space, but it was, in the final analysis, the Americans who made the whole thing pay off in spite of bureaucracy, red tape, government and corporate lethargy, and a surprising lack of nerve on the part of a lot of astronautics experts. It was the Americans, racing like hell with the Japanese and West Germans, who vindicated such early entrepreneurs as Basler, Henson, Sheffield, and Frazier. And, even at that, it wouldn't have been done without the political support from Teague, Schmitt, Stevenson, and Fugua, who were among the first to get bills rammed through Congress to provide incentives for the space entrepreneurs. The incredible wealth generated for America and its government by these measures has repayed the initial investments a thousandfold.

How strange it seems to have witnessed *all* of it! How little did we realize that the synergy of technol-

ogy would advance geriatrics and longevity so that we could! And it's only been 70 years, at that! The Prehoda Institute tells me every time I go back for a check-up that I've got another 50 years . . . and they keep up-dating that all the time. It is even strange to think back and realize that the original edition whose text is here was originally published on *paper*, that *trees* were cut down in order to permit its printing so that other people could read it. How far we have come in publishing so that now, with a thin plastic diskette covered with iron oxide, you can input this to your electronic book and read it while those trees that would have provided paper still stand.

I can't see those trees from here. Perhaps soon we will have some growing here anyway, but it's nice to go back every once in a while, just to smell the earth and see the sky and feel the breeze at your back. Even without those things, living here in space is much better. It's as though we were really meant to be here all along. Perhaps we were. But it took a lot of work to do it.

We *could* do it.

We *had* to do it.

And we *did* do it.

And all of us have a future to look forward to as a result.

—G. Harry Stine  
LaGrange Five Space Settlement  
26 March 2050

*Editor's Note: This article is the prologue to THE SPACE ENTERPRISE, which will be published in trade format by Ace Science Fiction in August of this year. To order, send \$5.95 to Book Mailing Service, Ace Science Fiction Division, PO Box 690, Rockville Centre, NY, 11571.*

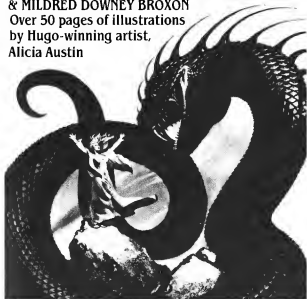
*In a vessel that sails on a timeless sea,  
a god sings of human mortality...*

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# THE CITY AND THE CRITICS

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JAMES GUNN

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"With singular unanimity, in any country where they had the chance the poor walked off the land and into the factories as fast as the factories could take them."

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The key debate of the nineteenth and twentieth centuries has concerned the direction of civilization. Earlier, a debate would have been impossible: people had no choice. But the Industrial and Scientific Revolutions introduced manmade change into human affairs, and suddenly humanity could choose: to go forward with more knowledge and more change, or to go back to a simpler existence. Soon the debaters settled into two camps: the scientists, who believed that the road led only forward, and the traditionalists, who thought people could stop or even go back, and that in any case art, culture, and life itself were better then. The debate continues to this day, only now it focuses on energy, pollution, and overpopulation.

The debate has been conducted in many forums: on lecture platforms, in newspapers, in public debate, and in magazines and books, in non-fiction and fiction. One of the two major symbols in the debate is the city. The other, of course, is the machine. Sometimes they come together as one, as in E. M. Forster's "The Machine Stops" or John Campbell's "Twilight."

What makes the city a symbol is that it is the epitome of the artificial. It must be built and maintained. It can be sustained only by heroic efforts. In the early days of civilization it was supported mostly by the unwilling sacrifices of the agricultural popula-

tion and justified itself as a center of trade and a place of defense. The rural population, of course, was not that interested in trade, and the city was mostly defending itself (cities and walls always went together; every city was a walled city); and even when the city mustered armies (often by levying troops from the countryside to preserve a kingdom), it often was defending itself from the attack of some other city-state.

On the other hand, the city also was the center of culture, science (such as there was), and change (such as there was). If the decision had been left to farmers and herdsmen, life never would have changed much, and one aspect of the criticism of more complicated technological existence has always been a kind of wistfulness for the simple life and its arcadian bliss.

The city is artificial. Its critics claim that this is a reason to damn it as dangerous and unnatural. Its supporters point out that "artifice" means "to make art," and making art is the most human activity.

Oddly enough, both the scientific culture and the literary culture were spawned by the city. Shepherds composing eclogues make a pretty picture, but a literary culture could scarcely exist outside the city. Symbols—and critics—are not necessarily consistent.

The most recent explosion of the debate between the literary culture and the scientific culture was precipitated by C. P. Snow in his 1959 lecture entitled "The Two Cultures." That lecture, and the debate that followed, now is so remote from the experience of many readers that some may not even have heard of it. In its time, however, it seemed to sum up the questions that were disturbing western civilization, and everyone was talking about it.

What Snow noted, first of all, was the existence of the two cultures and of a great gulf of misunderstanding between them. He expressed regret that most scientists were ignorant of literature but greater re-

gret that most members of the literary culture were ignorant of science. Although the tone was even-handed, the substance was not: Snow attacked literary intellectuals as "natural Luddites" who "have never tried, wanted, nor been able to understand the industrial revolution, much less accept it . . . . Almost everywhere . . . intellectual persons didn't comprehend what was happening. Certainly the writers didn't. Plenty of them shuddered away, as though the right course for a man of feeling was to contract out; some . . . tried various kinds of fancies which were not in effect more than screams of horror."

Snow saw "those two revolutions, the agricultural and the industrial-scientific" as "the only qualitative changes in social living that men have ever known" and noted that "with singular unanimity, in any country where they had the chance, the poor walked off the land into the factories as fast as the factories could take them." Against this, his major critic, F. R. Leavis, placed a "vision of our imminent tomorrow in today's America: the energy, the triumphant technology, the productivity, the high standard of living and the life-impoverishment—the human emptiness: emptiness and boredom craving alcohol—of one kind or another" and compared it with "a Bushman, an Indian peasant, or a member of those poignantly surviving primitive peoples, with their marvelous art and skills and vital intelligence."

"If the scientists have the future in their bones," Snow said, "then the traditional culture responds by wishing that the future did not exist."

This debate had been argued before by Matthew Arnold and T. H. Huxley, over whether science or Latin and Greek should be the focus of University education in England, and by Henry James and H. G. Wells, over the function of the novel. Differences of opinion about culture and tradition, and about

technology and the future, go back to a time not long after the beginning of the Industrial Revolution, to Blake ("dark satanic mills") and Emerson ("things are in the saddle and ride mankind") and Goethe ("one great discovery has followed another") and Tennyson ("better fifty years of Europe than a cycle of Cathay") and Ruskin. Ruskin, for instance, saw around him

signs of a slavery in our England a thousand times more bitter and more degrading than that of the scourged African, or helot Greek. Men may be beaten, chained, tormented, yoked like cattle, slaughtered like summer flies, and yet remain in one sense, and the best sense, free.

Ruskin went on to praise the age of nobility and peasantry when "famine, and peril, and sword, and all evil, and all shame, have been borne willingly in the causes of masters and kings."

Many years later Wells expressed an opposing view:

We are constantly being told that the human animal is "degenerating" body and mind, through the malign influences of big towns, that a miasma of "vulgarity" and monotony is spreading over a once refined and rich and beautifully varied world, that something exquisite called the human "soul," which was formerly quite all right, is now in a very bad way, and that plainly before us, unless we mend our ways and return to medieval dirt and haphazard, the open road, the wind upon the heath, brother, simple piety, an unrestricted birth-rate, spade husbandry, hand-made furniture, honest, homely sur-

gery without anaesthetics, long skirts and hair for women, a ten-hour day for workmen, and more slapping and snubbing for the young, there is nothing before us but nervous wreckage and spiritual darkness.

Henry Adams, in his classic comparison between the Virgin and the Dynamo, saw the Virgin as representing everything that was distinctively human, and the sexless dynamo as everything that was inhuman, pointing to the annihilation of human values, first by the achievement of an antlike society, and then by the victory of impersonal cosmic forces over life. One of his intellectual successors, Lewis Mumford, was a bit more balanced in his appraisal of technology in his book *The Myth of the Machine: The Pentagon of Power*. He admitted the "masterpieces of architecture and engineering" that produced the pyramids and their successors but placed these against

the use of the same engineering skill in destroying cities, ruining soils, exterminating innocent civilian "enemies," and mercilessly exploiting the mass of workers whose forced labor, disciplined to machinelike precision, made these feats possible.

And he pointed to contemporary variants of

such dehumanized megastructures, apart from Buckminster Fuller's other project of a city under a geodesic dome: plans for underwater cities, underground cities, elevated linear cities, cities a mile high, all compete for attention as the City (read Anti-City) of the Future. Whatever their superficial difference, all these projects are es-

entially tombs: they reflect the same impulse to suppress human variety and autonomy, and to make every need and impulse conform to the system of collective control imposed by the autocratic designer.

And Mumford goes on to say:

Beauty and wisdom, laughter and love, have never depended for their existence upon technical ingenuity—though they can be easily eliminated by devoting too much attention to the material means of existence, or attempting to play a game that subordinates all other human possibilities solely to the cultivation of abstract intelligence and to the electro-mechanical simulation of organic activities.

In all of this resides a definition not only of the machine and of the city but of humanity, a definition that is never stated because it is assumed to be universal. Lynn White, Jr., summed up the matter in a question in his *Dynamo and Virgin Reconsidered*:

Are humanistic values viable in a world more and more dominated not so much by science as by applied science, by technology? Must the miracle of the person succumb to the order of the computer?

White responds that the question has no good answer because it implies an opposition that does not exist:

technology and science are, and always have been, integral to the human adventure, and not things curiously alien from the concerns of our race.

This conflict, or apparent conflict, between human values and the products of humanity's attempts to free itself from the tyranny of natural process, which we call science and technology, has evidenced itself in the ways people have felt about the city. The city has simultaneously fascinated and horrified humanity from its beginnings. Gilgamesh, who is celebrated as the builder of the wall around Uruk, at the end of that epic asks his companion to examine the wall, "if its brickwork be not of burnt bricks, and if the seven wise men did not lay its foundation."

Throughout early history, the city was the place of riches and culture, where great religions were celebrated and cathedrals (like Uruk's "holy Eanna") were erected, where young men went to seek their fortunes or their fame, where poems were written and plays were performed, where great men made speeches and history, where trade routes met and everything was new and glittering. It also was the place of oppression, where revolutions were plotted, where barbarians waited outside the gates, where plagues began. Until recently cities always have had higher mortality rates than rural areas and have had to replenish themselves from the countryside in order to grow, or even to maintain their populations.

With the beginnings of the Industrial Revolution the definition of the city changed from the place of trade to the place of industry; intelligent people began to choose sides. For some the city became a place of pollution, where displaced farmers and their families were drawn into lives of rootless drudgery; for others it became the place of hope for better things, and a place that grew out of its own dynamism, a place that had the potential to become a new, possibly self-sufficient, and glorious environment for humanity. The traditionalists hugged their Arcadian visions and damned, with Blake, "the dark satanic mills," and the idealists looked beyond the



dirt and social problems to what the city could become.

Wells, the prophet of the future whose visions were attacked by a generation of cynics, presented an early modern version of the ideal city in his 1897 novelette, "A Story of the Days to Come," and recapitulated it in his 1899 novel, *When the Sleeper Wakes*. But his most vivid realization of the city came in his 1905 *A Modern Utopia*:

One will come into this place as one comes into a noble mansion. They will have flung great arches and domes of glass above the wider spaces of the town, the slender beauty of the perfect metal-work far overhead will be softened to a fairy-like unsubstantiality by the mild London air . . . . We shall go along avenues of architecture that will be emancipated from the last memories of the squat temple boxes of the Greek, the buxom curvatures of Rome: the Goth in us will have taken to steel and countless other new materials as kindly as once he took to stone. The gay and swiftly moving platforms of the public ways will go past on either hand, carrying sporadic groups of people, and very speedily we shall find ourselves in a sort of central space, rich with palms and flowering bushes and statuary. We shall look along an avenue of trees, down a wide gorge between the cliffs of crowded hotels, the hotels that are still glowing with internal lights, to where the shining morning river streams dawnlit out to sea.

Wells clung to rationality against the seductions of Joseph Conrad and Henry James and their talk of art.

There is nothing in machinery, there is nothing in embankments and railways and iron bridges and engineering devices to oblige them to be ugly . . . in Utopia a man who designs a tram road will be a cultivated man, an artist craftsman. . . . To esteem him a sort of anti-artist, to count every man who makes things with his unaided thumbs an artist, and every man who uses machinery as a brute, is merely a passing phase of human stupidity.

Even the Russian anti-utopian writer, Eugene Zamiatin, in his classic 1924 attack on the dehumanizing state entitled *We*, saw nothing necessarily ugly about the city:

Then, as this morning on the dock, again I saw, as if for the first time in my life, the impeccably straight streets, the glistening glass of the pavement, the divine parallelepipeds of the transparent buildings, the square harmony of the grayish-blue rows of Numbers . . . .

E. M. Forster's 1909 story "The Machine Stops" was a direct attack on Wells' utopian vision. Forster saw a future in which humanity had burrowed a hundred cities into the earth, and humanity had become so dependent upon the all-purpose "machines" that citizens seldom left their insectile cells.

Imagine, if you will, a small room, hexagonal in shape, like the cell of a bee. It is lighted neither by window nor lamp, yet it is filled with a soft radiance. There are no apertures for ventilation, yet the air is fresh. There are no musical instruments, and yet, at the moment that my meditation opens,

this room is throbbing with melodious sounds. An arm-chair is in the centre, by its side a reading desk—that is all the furniture. And in the arm-chair there sits a swaddled lump of flesh—a woman, about five feet high, with a face as white as a fungus.

Forster's vision was controlled by his perception of the machine as basically limited and fallible: machines trim people to the machines' measures, and they break down. Moreover, Forster saw people as corruptible, as incapable of governing themselves or their creations:

Time passed, and they resented the defects no longer. The defects had not been remedied, but the human tissues in that latter day had become so subservient, that they readily adapted themselves to every caprice of the Machine. The sigh at the crisis of the Brisbane symphony no longer irritated Vashti; she accepted it as part of the melody. The jarring noise, whether in the head or in the wall, was no longer resented by her friend. And so with the mouldy artificial fruit, so with the bath water that began to stink, so with the defective rhymes that the poetry machine began to emit. All were bitterly complained of at first and then acquiesced in and forgotten. Things went from bad to worse unchallenged.

The science-fiction writers of the Thirties and later looked at both man and machine differently. In some ways their optimism was naive, but in other ways their grasp of the reality of change, their understanding of the fact that the future was going to be different from the present just as the present was different

from the past, and their delighted anticipation of change rather than repulsion by it, allowed them to conceive of the future in more realistic ways, to look beyond the imperfect present to the ideal. John W. Campbell, the long-time editor of *Astounding/Analog* who imprinted his personality on the science fiction of the Forties and Fifties, wrote a 1934 story about the city as it might be, "Twilight." For him, as for Wells, the essence of the machine was that it worked; a machine that failed was a machine that had been inadequately conceived or carelessly constructed:

Twilight—the sun has set. The desert out beyond, in its mystic, changing colors. The great metal city rising straight-walled to the human city above, broken by spires and towers and great trees with scented blossoms. The silver-rose glow in the paradise of gardens above.

And all the great city-structure throbbing and humming to the steady, gentle beat of perfect, deathless machines built more than three million years before—and never touched since that time by human hands. And they go on. The dead city. The men that have lived, and hoped, and built—and died to leave behind them those little men who can only wonder and look and long for a forgotten kind of companionship. They wander through the vast cities their ancestors built, knowing less of them than the machines themselves.

Here is no simple optimism about humanity. Humanity has lost the quality that made it human—not those gentler virtues that Mumford extolled but curiosity. In the story the protagonist, before he returns to his own time, sets a machine to creating a

curious machine that will inherit man's search for meaning in an enigmatic universe.

A vision more distant than "Twilight" is recorded by Arthur C. Clarke in *The City and the Stars*, first published in 1956 although it is a substantial revision of a novel entitled *Against the Fall of Night* whose magazine version was first published in 1948 and book version in 1953. In *The City and the Stars* humanity has created a city called Diaspar in the far distant future. Like Campbell's cities in "Twilight," Diaspar is eternal; more than that, its population exists in the form of information in the Memory Banks of the Computer that maintains and runs Diaspar; only a hundredth of the citizens are alive at any one time while the rest await rebirth. Outside, the oceans have evaporated, the mountains have been ground to dust, and the Earth has turned to desert; Diaspar is not only a repository for humanity and a protection against the fall of night but a prison, for its citizens have been impressed with a fear of the outside and cannot leave. Here, too, is no comfortable vision, even though one youngster, without previous existences, fights free of Diaspar and gives humanity a new future.

Dozens of future cities rise out of the literature of science fiction like monuments to humanity's dreams and ingenuity: James Blish's self-contained spacegoing cities (analogous to Swift's flying island of Laputa); a nagging, Jewish-mother of a city in Robert Sheckley's "Street of Dreams, Feet of Clay"; a city within a skyscraper in Robert Silverberg's *The World Inside*; an entire planet as a single city in Isaac Asimov's *Foundation*; and a Dyson sphere around a sun as a city in Bob Shaw's *Orbitsville*.

But I would like to conclude this brief look at the city with Asimov's more immediate vision, in *The Caves of Steel*, of a New York a thousand years from now:

Efficiency had been forced on Earth with increasing population . . . . The radical change had been the gradual formation of the Cities over a thousand years of Earth's history. Efficiency implied bigness. Even in Medieval times that had been realized, perhaps unconsciously . . . . Think of the inefficiency of a hundred thousand houses for a hundred thousand families as compared with a hundred-thousand-unit Section; a book-film collection in each house as compared with a Section film concentrate; independent video for each family as compared with video-piping systems. For that matter, take the simple folly of endless duplication of kitchens and bathrooms as compared with the thoroughly efficient diners and shower rooms made possible by City culture . . . . City culture meant optimum distribution of food, increasing utilization of yeasts and hydroponics. New York City spread over two thousand square miles and at the last census its population was well over twenty million . . . . Each City became a semi-autonomous unit, economically all but self-sufficient. It could roof itself in, gird itself about, burrow itself under. It became a steel cave, a tremendous self-contained cave of steel and concrete.

It could lay itself out scientifically. At the center was the enormous complex of administrative offices. In careful orientation to one another and to the whole were the large residential Sections connected and interlaced by the expressway and the localways. Toward the outskirts were the factories, the hydroponic plants, the yeast-culture vats, the power plants. Through all the melee

were the water pipes and sewage ducts, schools, prisons and shops, power lines and communication beams. There was no doubt about it: the City was the culmination of man's mastery over environment . . . .

The Cities were good.

That evaluation comes from Asimov's protagonist, a city dweller who feels uncomfortable without the press of other bodies around him, who is psychologically incapable of going outside his cave of steel, rather like Forster's Vashti, because he, like his fellow citizens, suffers from agoraphobia. The difference between Asimov and Forster, however, is not so much in their abilities as writers as in their perceptions of humanity. Forster, like Ruskin and Mumford, saw humanity as fallen from a better state; Asimov sees humanity not as perfectible but as adaptable. He sees humanity expressing its essential humanness no matter how strange the circumstances; he sees it as persevering—even, like Faulkner, as prevailing.

Humanists, as representatives of the literary culture, tend to cherish the poetic vision, to prefer the artistry of tragedy to the optimism of comedy, and to reject prosaic reality, "as if the right course for a man of feeling was to contract out," as Snow put it. But if the humanities and science are placed in opposition, there can be no question as to which will be the loser—not that science can win without human values but that the humanities no longer can be imagined to exist in a world without science. The question to be resolved by our times—and the time may be getting short—is not whether the literary culture is correct about the fallen state of man or the scientific culture is right about humanity's potential for improvement but whether they can recognize that no real conflict exists between them.

—James Gunn

# the Patchwork Girl

by **LARRY NIVEN**

author of  
**THE MAGIC GOES AWAY**

co-author of  
**LUCIFER'S HAMMER**

Naomi Mitchison, the most beautiful woman  
on the moon, is charged with murder and must repay society  
with bits and pieces of her body (an "eye for an eye").

But investigator Gil Hamilton knows she is innocent  
and is working very fast to keep her  
from becoming "The Patchwork Girl".



**LARRY  
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# **SCIENCE WITH DICK AND JANE**

Lesson One: Electricity

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SANDRA E. KOESTER



---

Jane's theory  
of the Electrocule  
can be compared in  
importance and insight only  
to that of Phlogiston...

---

Dick sat cross-legged at the head of the bed, between the two pillows facing the wall while he worked on the lamp cord.

"If we had a headboard, like you want," said Jane, "you wouldn't be able to install that switch so conveniently."

Above the head of the bed was a small, wall-mounted reading lamp. Its control switch was at the lamp base, an awkward reach even for someone sitting up in bed. However, since the cord hung down against the wall, between their pillows, Dick was installing a switch a few inches above mattress level, on the cord itself.

"If we had a headboard like I want," said Dick, "I wouldn't have to do this at all."

Jane folded the laundry while Dick worked. "There," he said. "All finished. Want to try it?"

Jane knelt on the bed and pushed down on the little circular wheel of the switch. Nothing happened.

"Wrong direction," said Dick. "Push it up."

She did. Again, nothing happened.

Dick checked to make sure the cord was plugged in. It was. Then he grinned sheepishly and turned the switch on at the base of the lamp. "Try it again. Push up."

Jane did, and the light went on. "Very nice, dear," she said, sliding off the bed.

Dick switched the lamp off and began straightening the disorder at the head of the bed. Jane went back to her laundry. When Dick finished, he glanced up to see Jane looking at the lamp cord speculatively. "What's the matter?"

"Well, I was just wondering." Jane was still looking at the cord. "When you turn the lamp off at the cord, what happens to all the little electricules that are trapped between the switch and the lamp?"

Dick blinked. "The what?"

"You know. The little buggers that make up a stream of electricity."

"I don't understand what you mean."

"When you turn the switch on," Jane explained patiently, "the electricity flows from the switch up to the lamp."

"Right."

"But when you turn the switch off, they're trapped. They can't go up anymore, because there aren't any more electricules behind them to push; you cut them off. And they can't slide back; you created a gap they can't jump. So what happens to them?"

Dick looked at the cord. "I don't know."

Jane frowned. "I'll find out," she said.

"Darn it, Jane!" Dick hollered.

"What's wrong, dear?"

Dick was sitting on the floor, sucking his finger. "I bent my fingernail trying to get this blasted thing off. It's bleeding."

"I'll get you a Band-aid. Why didn't you use a



screwdriver? They come off very easily with a screwdriver." Jane left to get the Band-aid.

"Because I don't *want* to traipse all the way downstairs for a screwdriver," Dick muttered around his finger, "just to plug something in in the living room. Jane!"

Jane returned and bandaged his finger. "Don't holler, Dick," she said calmly. "It's only a split fingernail."

"That's not the point. Every time I want to plug something in, I have to pry these darned child-proof caps off the outlet. Look! They're all over the place. And we don't have any kids." He looked at her accusingly.

"Would you like children, Dick?" said Jane softly.

Dick sighed. "That's not what I meant. I meant, why do we have to have child-proof caps on all the electrical outlets?"

"So the electricules don't get out, naturally. They

don't like plastic." Jane walked towards the kitchen.

"Wait a minute." Dick scrambled to his feet and followed Jane. He put his hands on his hips. "Maybe," he said, "you'd better explain this to me."

"Not if you're going to act silly."

Dick grinned. "It's just that I never heard that particular scientific term before."

Jane pouted. "So okay, it sounds silly. I just call them that precisely *because* there's no particular scientific term for them. You know George next door. He's an electrician. Does *he* understand electricity? No. And Dr. Wattinger at church. He's a scientist. Does *he* understand electricity? No. So why is my attempt to put things into terms that I *do* understand so ridiculous?" Jane looked at Dick expectantly, demanding an answer.

Dick shrugged, unaccountably embarrassed. "I guess it isn't."

Jane turned and stomped back into the kitchen.

"Jane," said Dick, following her, "the electricity will not leak out of the outlets."

"Of course not. I told you they don't like plastic."

"I think we have a communications gap here," Dick said. "Jane, they won't leak out even without the plastic caps."

"Oh yes they will," said Jane, scanning a recipe rapidly. She went for a measuring cup as Dick sat down at the kitchen table. "Don't you remember how they used to leak out all over the carpet? You hated to turn on a light for fear you'd get a shock. And the kitty wouldn't let anybody come near her. Well, the plastic caps stopped all that nonsense. Although," Jane paused in thought, then continued with her food preparation, "I can't say it really helped our energy bill any."

"Jane, the static electricity is caused by the dryness in the air, not by electricity spilling onto the carpet."

"Now, that doesn't make any sense," Jane coun-

tered. "How can dry air be, of itself, a cause of static electricity?"

"It isn't. It's dry air combined with the type of carpet we have."

"That makes even less sense." Jane gestured with a sticky spoon. "On the one hand you have dry air. On the other, you have a kind of carpet. Where does the electricity come from? And don't say thin air."

"It comes from the dry carpet." Dick sounded a bit exasperated.

"Like spontaneous generation, I suppose." Jane put her spoon down. "Look, dear. I could say that scientists embrace a cult of deliberate obscurity, but they're only trying to explain things in their own language. But you know how I try always to look for the simplest solution and the most reasonable. So listen. The electricules *do* leak out—oh, not in huge bunches, but they do get out. When the air is dry, they run wild all over the carpet, especially our kind, which they obviously like. But when the air is a little humid, they get caught in the teensy water droplets. Not being strong enough to break the surface tension of the water, they can't get out. They eventually lose their charge, which dissipates into the air, and they die. See?"

"I think I need a cup of coffee," Dick said.

"I finally figured it out, Dick," said Jane in the darkness.

"Mmff?" Dick raised his head from the pillow.

"I know where the trapped electricules go."

"Swell." Dick turned over, bunching the covers up around his neck.

"No, really. Look. They leaked out of the switch and onto the bed."

Dick looked. Jane rubbed her hand rapidly back and forth across the sheet on the mattress. Blue sparks glittered in the dark.

"Come on, Jane. That's from the friction against the plastic sheet that we have on the mattress." Dick turned over again.

"Not only carpets generate spontaneously; now it's plastic sheets, too," said Jane.

"Mmff?"

"Goodnight, dear."

"Mmff."

"Excellent dinner, Jane," Dick said, sipping his coffee. "How do you like the microwave oven?"

"I love it," said Jane. "Of course, like anything new, it takes getting used to. A readjustment in your concept of what actually happens when food cooks."

"Simple," Dick grinned. "It's just a lot of micro-cules running around."

Jane made a face. "Very funny. As it happens, though, you're pretty close."

"You mean there really are microcules?"

"Don't be silly. I know what a wave is, be it light, sound, or micro. Do you know what a current is?"

Dick raised his eyebrows in an innocent expression. "I do when I grab hold of one." Jane moued a pretty pout over her coffee cup. "What's your version?"

"Well," Jane put her cup down, "I think electricity is made up of very tiny particles, smaller than, perhaps, an atom. I call them electricules. They are just the right size and shape to dash through molecules of metal and water, but can't get through other molecules, like wood or plastic."

"Wait a minute," said Dick. "Some plastic molecules, I understand, are pretty big."

"Size doesn't matter all that much," said Jane. "Electricules have an affinity with metal. They're attracted to it and at the same time it repulses them, depending upon the nature of the charge involved. Plastic, though, is pretty dead."

Amazing, Dick thought. "But if other molecules are



smaller, how do the—things—get through?"

"Oh, come on, Dick," Jane said, a bit irked. "You know that an atom looks kind of like the solar system. So what single thing does the solar system have the most of?"

Dick thought a moment, feeling curiously like a little boy at school being called on to recite. "Space?" he said tentatively.

Jane smiled. "Right. Or hydrogen, I'm not sure. Anyhow, it's easy for the electricules to get through. And shape is important because sometimes they go through in a straight line and sometimes they kind of do-si-do."

"DC and AC," Dick said.

"Right again," said Jane. "But they can't get through large gaps; the affinity with the metal molecules decreases with distance and they can't get up enough oomph."

Dick smiled. "Enough what?"

"Oomph." Jane giggled. "Look, I'm feeling pretty ridiculous."

"Go on," Dick grinned. "This is fascinating."

Jane began clearing the table. "That's how the electricules dance through the wires. I really envision the little buggers having a ball, especially when you turn on a switch and they get to go all over—light bulbs, toaster heating elements, even pulsing around in your computer. That must really be fun—like a stylized, formal ballet sometimes, and other times like a fast, intricate square dance."

"With me as caller, I suppose," said Dick, carrying dishes into the kitchen. "Now *that's* a picture!"

"Being so small," Jane continued, "and pretty frisky, they try to go all over, which is why we have to wrap wire with plastic."

"So they stay where they belong," said Dick. "Along that line, then, lightning must really be wild."

Jane nodded. "Savage," she said. "Most domesti-

cated electricity is really just exuberantly friendly, which is why you get shocks. They're merely getting acquainted with a cousin: your body electricity. But lightning isn't tame; it's uncontrolled and, like I said, savage. Tame electricity doesn't mean any harm; it has fun with all the neat things it's allowed to do. But lightning likes to smash blindly into things."

"I see." Dick leaned against the sink, watching Jane load the dishwasher. "What about batteries?"

"Oh, gosh," said Jane with dismay. "See, electricity is vivacious, buoyant with fun and full of life, mostly because it's free, within certain limitations. Just like anything that is alive. But the electricules in batteries are packed in—they can't move—and they're only allowed out in teeny bunches and can't get back in. When they do get out, they are so demoralized they can't do much. Plus they are usually only allowed to do one thing, and generally they die doing it. It's really the worst form of slavery. Naturally, if they are cooped up too long, they die in the battery."

Dick was silent for a moment, framing a response. "Why don't you publish this theory of yours?" he asked. "You could form a Society for the Prevention of Batteries, hold marches . . ."

"Stage sit-down strikes in hardware stores . . ."

"Send flowers to power plants . . ."

"But only on Mother's Day." They both began to laugh. "Want to watch some television?" Jane asked.

"I guess so."

"Dick?" said Jane. "You forgot to turn off the light."

Dick went back and stared at the switch for a long moment. He reached up and put a finger on the switch, then flicked it.

The light went out.

—Sandra E. Koester

# THE L-5 REVIEW

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The Editors of L-5 NEWS

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SCHMITT: You'd better start listening to the young people, Mr. Chairman.

PROXMIRE: I listen to them. Sometimes I wish I didn't have to, but they vote at eighteen now.

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*Free Enterprise and the Proposed Moon Treaty*  
Art Dula

International Law allows sovereign states complete freedom to engage in any activity that is not expressly prohibited by law. Today the U. S. has a perfect right to exploit space resources for profit. The Moon Treaty does not give the U.S. new rights, it only limits existing U.S. rights to use space resources for scientific purposes and takes away the U.S.'s existing right to exploit such resources for profit. It must be stressed that the Moon Treaty does not create even a single new right beyond those the U.S. already enjoys under existing international law. Far from being a fair balance between the needs of free enterprise and

the less developed countries, the Moon Treaty is a dangerous and unrealistic abandonment of basic legal rights that free enterprise will need to work effectively in space. The Moon Treaty introduces substantial uncertainty and risk for private sector investment in space ventures that would exploit space for profit.

Space industrialization requires the establishment of realistic laws. To determine what law will be appropriate in space, it is necessary to examine why humanity is expanding into this new environment. Three principal forces, the academic, military and commercial, interact to impel humanity into space. With the exception of communications, U.S. involvement in space is entirely academic or military. Present space law, including the Moon Treaty, has been forged almost entirely out of academic ideals in *advance* of any practical commercial ventures. In this author's opinion, practical business space law would, if not preempted, evolve shortly after spacebased exploitation of basic resources and energy begins to yield substantial profits. History teaches that the transition between academic and practical legal regimes can be gradual or traumatic, but that such transitions occur.

Ominously, the world now spends more for military purposes in space than for academic studies. The only remaining substantial possibility for free enterprise non-military development of space requires large scale development of basic natural resources, i.e. raw materials and energy from space. Only basic raw materials and energy from space can return a profit commensurate with the capital expense and risk that will be required to start up space industry. Only large scale development of these basic space resources can provide sufficient economies of scale to permit development of space as an industrial frontier by free enterprise capitalism.

Such large capital investments cannot be made without clear legal guidelines that allow commercial operations to exploit space resources for profit. Free enterprise institutions simply cannot make significant investments in space while they are under the threat of suit over treaty terms of ex post facto appropriation of their investments by a nebulous future international regime.

Finally, it is clear beyond reasonable doubt that the U.S.S.R. and its supporters in COPOUS have and are executing a careful and deliberate program intended to limit the entry of free enterprise into space. Since the U.S.S.R.'s introduction of the draft Treaty of Principles in 1962, the Soviet Union and its allies have fought constant delaying actions to chill free enterprise investment in space as a new industrial environment. It is an unfortunate commentary on the will and vision of the United States and other Free World nations that the U.S.S.R.'s program has been so successful.

(A different version of this article was published in the Winter 1979 *Houston Journal of International Law*.)

*Hasty Moon Treaty Interpretations May Mislead*, Edward R. Finch, Jr., L-5 Society non-governmental organization delegate to the United Nations.

The Committee on the Peaceful Uses of Outer Space has already produced by consensus five treaties which have been ratified by the U.S. and which have made exemplary progress in the law of outer space. This treaty seems most appropriate, considering the rapidly advancing science for the use and development of resources from space for the benefit of all mankind.

The L-5 Society should encourage informed debate

on the interpretations of the proposed treaty. To be avoided are hasty interpretations, inappropriate analogies and unwise political action tending to diminish L-5's role in advancing activities in outer space.

In particular, it is my feeling that there should not be "quick . . . political action in Washington" with regard to defeating this treaty before the U.S. Senate as suggested by Leigh S. Ratiner (the L-5 Society Washington representative).

The Soviet Union, by its Delegate Kolossov, indicated before COPOUS that his delegation would "make no hasty interpretation of the meaning behind each article of the draft agreements, its possible impact on further developments in international cooperation in outer space, or its potential impact on the further development of international space law." U.N. Doc. A/AC.105/PV.203. The writer supports this view as do many other outer space lawyers. Hasty analogies to the law of the sea can result in misleading presumptions and conclusions. Lawyers who have worked in *outer space* international law understand the dangers in attempting the application of analogies from elsewhere to the unique space environment.

*Robert C. Truax: Crackpot or Pioneer?*  
Carolyn Henson

Some people, in response to Bob Truax's noble (i.e., cheap and privately financed) astronaut program, have written him off as a nut. After all, what "professional" would plaster his rocket with ads or, in this post-Nader culture, let his astronauts face a several percent probability of death?

Truax graduated from Annapolis in 1939. By 1942 he was given charge of the Navy jet propulsion project. Later, through the Naval Research Laboratory,

he developed the Navy's rocket capability.

Truax, as head of the American Rocket Society (now known as the American Institute of Aeronautics and Astronautics, the professional organization of aerospace engineers) generated a recommendation in 1957 to U.S. President Eisenhower to develop a strong non-military space program. Eisenhower agreed and created NASA.

In 1960 Truax became the head of advanced development for Aerojet Engineering Corp. While there he pushed for ocean recovery of reusable rockets—a concept finally adopted for the Space Shuttle's solid fuel engines.

In 1974 he convinced stunt artist Evel Knievel to try to jump the Snake River in the rocket-powered "Sky-Cycle." Either the mission-abort parachute opened by itself, or Evel chickened out—who can say? But Truax's Sky-Cycle flew just fine.

Truax certainly doesn't fit in the grey NASA/aerospace mold. But, whatever the fate of his X-3 Shuttle program, Bob Truax already has a solid place in the annals on the evolution of the space age.

### *Space Colonization in the Classroom,* Lawrence C. Wolken

Since the early part of this decade, public interest in space has declined. The major problem facing space enthusiasts is how to make the general public aware of the potential benefits of space.

Few people have turned their attention to the public schools as a solution to this problem. An ideal forum for the study of the potential benefits of space is American history, a course that must be taken by every student in the country and thus could provide the broadest possible exposure for information about space. The main obstacle to such a program, of



course, is the problem of motivating history teachers by showing them how this approach will redound to their advantage. Their enthusiastic support is essential; what follows is an argument designed to that end.

Supposedly a main reason we study history is to learn from past mistakes. However, it is often difficult for today's youngsters to see how the problems of previous generations apply to the radically changed realities of the high-tech present. Space can help bring history to life.

Some obvious parallels between past and present: Columbus and other explorers were financed by governments; the same is true for the U.S. and Soviet space programs. The New World produced many resources and untold riches for the Old World; will space, through solar power satellites, provide the world with the energy it so desperately needs? Sugar and gold, beaver pelts and religious refuge, all were gifts of the New World; what other presently unknown riches does space have to offer us? The early colonies in America were financed through private investments by companies seeking to make a profit; will the first space colonies be financed by private or public funds? This is a question being hotly debated in Congress today. These are just a few of the more obvious similarities between the past and the present. Many other parallels exist but are less well known.

Prince Henry of Portugal built a shipyard to develop new types of sailing ships which could sail in the open waters of the Atlantic Ocean. He also started a special school for navigators where they experimented with new methods of navigation, maps and instruments. How different is Henry the Navigator's approach from the NASA centers, the training of astronauts, and the development of the aerospace industry?

Beginning in the latter part of the fifteenth century, many European nations were interested in finding a new route to the riches of Asia. The ensuing period of exploration and discovery was dominated by two countries, Spain and Portugal. Spain concentrated its efforts in a westerly direction while Portugal sent its explorers around Africa. Also emerging during this time period were natural rivalries as strong monarchs competed for national power and prestige.

A similar situation is occurring in the twentieth century. In this early stage of the exploration of space, the United States and Soviet Union are the dominant countries. The Cold War between the two world powers played an important role in the race to the Moon during the 60's. Will America and Russia lose their world leadership positions just as Spain and Portugal did? Will Germany, Japan, and China, through efforts in space exploration and colonization, emerge as the dominant nations of the future? Or some other nation? Who? Or can the United States "learn from the mistakes of the past"?

During the American colonial period England viewed her colonies as a means of increasing England's power and wealth: the mother country developed manufacturing and established monopolies in foreign trade so it could accumulate gold and silver through a favorable balance of trade. The colonies provided a readily available supply of natural resources and a market for manufactured goods. The mercantile system led directly to the American Revolution. When the United States establishes its first space colonies will we repeat England's colonial policies? Will the United States be the "mother country" of the next American Revolution?

Today's generation of students may become the first inhabitants of space colonies. What type of government will be set up in the colonies? Will a constitution be adopted? Can future space colonists ben-

efit from years of experience and draft a better constitution? Many of today's students may very well face this question during their lifetime.

For those who want to develop a greater public understanding of space and its potential benefits, the history classrooms of the nation offer a golden opportunity. This will not yield immediate results but its effects will be widespread and long lasting. Today's students will be tomorrow's voters and will help shape the nation's goals. Perhaps the most important decision they will face is whether humankind will venture into space or remain bound to the Earth's surface.

For further information about incorporating the exploration and colonization of space into history classes contact Dr. Lawrence C. Wolken, Center for Education and Research in Free Enterprise, Texas A & M Univ., College Station, TX, 77843 (713-851-7722).

### *Space Foxholes, or Beetle Bailey in Orbit,* H. Keith Henson

At any given time, over a billion dollars worth of U.S. hardware is circling the Earth, and the defense of this stuff, which has become vital to the military, has a lot of people worried. To date, very little has been done about these worries because there has been little to be done.

Given the array of possible antisatellite weapons, shrapnel, lasers, particle beams, ordinary high explosives and nuclear bombs, what defense methods would work for all of them? The obvious method would be the space foxhole or bunker. Six feet of common dirt around the sensitive parts of a spy satellite would make it immensely harder to put out of action by any of these weapons. The problem is that a

six-foot shell of dirt around an object the size of a shuttle bay would weigh around 1000 tons. Boosting this much mass into orbit would require about 70 shuttle launches and would cost about 2 billion dollars.

Still, the advantages of armoring satellites are so great that it might be worthwhile even at this cost (not least because putting things in holes or under the sea where they are hard to knock out has a non-aggressive image; why bother if you are going to strike first?). The alternate response to anti-satellite weapons is to threaten the other side's satellites with your own weapons. Those of you who read *Aviation Week* and *Space Technology* know that this is the path the U.S. is currently taking. This approach has little to recommend it, especially since the differences between U.S. and U.S.S.R. spy satellites would make an exchange much more costly to the U.S. Our satellites are large, expensive, and long lived. The U.S.S.R. tends to launch, on need, much smaller and shorter lived satellites and, unlike the U.S., keeps a ready reserve.

The use of extraterrestrial materials has not (to my knowledge anyway) been seriously considered for military applications, but it is obvious that if a method were available to get thousands of tons of dirt to the orbits used for spy satellites, a ready market would exist. As a guess, the military might be willing to pay 2 or 3 billion for 3-4 parking garages in orbit for its spy satellites, and perhaps half of that to armor its communication and navigation satellites. If this is a good guess, then the military market is the next largest, after solar power satellites (SPS). Furthermore, for this purpose the material needs little or no processing to be useful.

It's a long way from military space bunkers to the human habitation of space, but other than the SPS project, the space bunkers are possibly the only

extraterrestrial-resources project that might be economically justifiable. Extraterrestrial resources are, as we well know, *the* key to space habitation.

A 3 or 4 billion dollar market, large as this is, does not necessarily lead to an O'Neill-style space development (although it would help if, for example, an SPS project were in the works.) The Moon base/mass driver cost estimates are in the range of three times the total market.

But the Earth and the Moon are hardly the only sources of dirt in the solar system. We have run our remote fingers through the sands of Mars and photographed the regolith of Deimos (the larger of the two Martian moons). In the context of solar sails, Deimos may be one of the most accessible objects in the solar system. Trip times for light sails would average four months on the outbound leg and a year on the inbound leg. Sail production rates of one per month would start returning material at a rate of 100 tons per month. As the sails begin to be reused, about a year and a half later, the rate would go up to 200 tons per month. This sort of thing could go on for a long time before we took a noticeable bite out of Deimos.

What would be needed for this project would be a solar sail production facility, remotely-operated carpet sweeper, a remote launch/docking tug to move bags of regolith from the surface of Deimos to attachment with the light sail, and the kind of mission control we have recently used for Viking. Initially this project does not call for any people in space for long periods of time, consistent with the "scaled down" space program. People would probably be present during mixing of the regolith with a binder, and molding the bunkers, but that should not take more time than the shuttle orbit stay-period of 7 days.

There are numerous advantages to a program to mine Deimos by remote control. The existence of a

transport system of light sails would make the wildest remote explorations of the outer planets feasible: a one and a half year Pluto flyby for example. A Mars sample return could be tacked on to the Viking program, probably at less cost than the Viking program. Sample returns from the asteroids would be easy as well.

The most significant advantage of this project is that it gives us a toehold in space. Once we have a steady supply line for extraterrestrial materials, we can build shielded habitats where people can live their lives without cosmic ray damage. We will possess the raw materials to build farms and factories. We will have made the step from being visitors in a hostile environment to being homesteaders in the promised land.

### *News Briefs*

Veteran space sciences foe, *Rep. Boland (D-MA)*, is still trying to kill the *Jupiter Orbiter Probe*, now renamed *Galileo*. A combination of shrinkage in the weight the Shuttle is expected to be able to launch and growth in *Galileo's* expected weight have forced researchers to separate its experiments into two launches. Boland says that makes *Galileo* a new project, which would require a special approval from all four congressional subcommittees overseeing it—one of which Boland chairs.

NASA is expected to resubmit *Galileo* for approval shortly. In the interim, a *House/Senate conference committee* has authorized NASA to continue work.

How bad are Shuttle thermal protection tile problems? Seven percent of all tiles failed the recent "pull test" which checked their bonding to the orbiter.

A better tile is under development for the next orbiter, 099.

*The first flight of Ariane, the European Space Agency launcher, is scheduled for a date in December, 1980. Arian has been developed at a cost of \$660 million, about 1/10 that of the space shuttle. Unlike the shuttle, Ariane will not carry people but will be capable of delivering 1.26 tons to geosynchronous orbit. This compares with 1.8 for the shuttle. Ariane is also expected to offer slightly cheaper launch costs.*

Ariane's first commercial payload will be Amsat, a satellite developed by and to be used by radio amateurs. Launch is scheduled for March 1980.

An improved Ariane, scheduled for 1983, will be able to loft 2.3 tons into geosynchronous orbit.

The Space Shuttle is expected to get the extra funding needed to ensure that it will fly no later than the fall of 1980. The reason? *Carter needs Shuttle capabilities for verification of Soviet military strength under Salt II.*

How bad are Shuttle cost overruns? According to NASA, in 1971 FY dollars the project has expended \$6.115 billion, 18½% over the original expectations.

Staunch R&D and space program defender, *Sen. Adlai Stevenson (D-IL)*, has announced that he is "available" for the Democratic Presidential nomination. Recent Stevenson initiatives include a bill to make it easier for government contractors to retain patent rights, and a "peace-keeping" spy satellite system which any nation on Earth could use to ensure its security.

Earlier this year Stevenson led an unsuccessful battle to save the Enterprise from being scrapped.

Debate on the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* opened in the United Nations Political Committee Oct. 29. The treaty is expected to be approved by an overwhelming majority of the U.N. General Assembly.

The treaty, however, is facing mounting opposition within the United States.

The *Salyut-6 radio telescope* became tangled with other parts of the space station and *had to be discarded* by a spacesuited crew member shortly before the team returned to Earth August 19.

### *Proxmire's Waterloo?*

Ken McCormick

President Carter's Office of Management and Budget cut \$208,200,000 from NASA's request for Research and Development funding for fiscal year 1980. Rep. Boland's House Appropriations Subcommittee cut an additional \$23,000,000 from the R&D budget. But Senator William Proxmire wasn't satisfied that enough had been done to curb federal spending. When the NASA budget was marked up in his Subcommittee on HUD—Independent Agencies, he moved to cut \$138,400,000 from NASA R&D. And he might have succeeded, had it not been for a save-NASA campaign by Senators Charles Mathias and Jack Schmitt.

As the ranking minority member of the Senate subcommittee, Mathias has been the principal defender there of the NASA budget for several years. This year, he has been joined by the dynamic senator from New Mexico. Schmitt's scientific training and experience as an Apollo 17 astronaut have provided him with a technical expertise which Mathias has found invaluable. Despite Proxmire's powerful position as Subcommittee Chairman, the Schmitt-Mathias combination proved too much for him this year.

Proxmire's main targets were the Galileo Jupiter orbiter and probe and the Large Space Telescope. His proposed \$83 million reduction of the \$116 million FY 1980 allotment for Galileo would have crippled



that program, and in the opinion of one Mathias aide, Proxmire would have moved to entirely kill Galileo next year if he had been successful this year. The proposed \$25 million cut in the Large Space Telescope program was aimed at a one year stretch-out of the program. Mathias aides say that a one year stretch-out of the program, although it would have reduced the federal budget by \$25 million this year, *would have ultimately cost the taxpayers at least \$50 million extra*, due to the costs of maintaining the program over a longer period of time. Proxmire would have also cut \$20 million for Space Shuttle thrust augmentation, \$8.4 million for aeronautical projects, and \$2 million for lunar sample analysis, (leaving \$2 million in that program).

Proxmire had made it clear by his remarks in the pre-mark-up hearings that he would move to cut the NASA budget, but the magnitude of the cuts he was to propose still came as something of a surprise. Schmitt and Mathias had been working steadily to line up votes behind their own proposal for the NASA budget. When they learned the specifics of Proxmire's plan, just one day before the subcommittee mark-up of the Appropriations bill, they redoubled their efforts.

A staff member of Sen. Stevenson's Subcommittee on Science, Technology and Space joined Schmitt and Mathias aides in extolling the virtues of programs which OMB had nixed and programs which Proxmire's cuts would cripple. Mathias called in favors. Schmitt made deals. One by one, senators, some of whom have no special enthusiasm for the space program, lined up behind a very progressive amendment to the Appropriations bill which would allow NASA to initiate the development of programs which OMB had cut from the budget. By the time the showdown came, the only senators on the eleven-member subcommittee who were not known to be

planning to vote with Schmitt and Mathias were Senators Sasser, Bellmon and Durkin.

Few senators have positions on any issue that stand in more diametric opposition than those of Sens. Proxmire and Schmitt on the space program. The head-on collision of these two men in pre-mark-up hearings on the FY 1980 NASA budget provided some dialogue which illuminates, on the one hand, the attitude of perennial budgeteer Proxmire, and on the other, the expansionist philosophy of former scientist-astronaut Schmitt.

Proxmire kicked off with the complaint that the President had sent a NASA budget request to Congress which would allow "significant increases" in funding for certain individual programs such as Galileo and the Large Space Telescope. Proxmire wondered how the Administration could countenance a 20% funding increase for space science in the face of Carter's resolutions to fight inflation. The Congress must do its part, he said, by reducing the profligate spending on space science.

Schmitt complained in his opening remarks that the President's budget request was insufficient to maintain U.S. leadership in space. "The President has failed," said Schmitt, "to meet his commitment that we as a nation are not going to minimize or decrease our commitment to space at all.

"There is no clear commitment in this budget . . . to rapidly rebuild our technology foundations and the economy that goes with those foundations—the economy of the future.

"I am afraid that without absent appropriate congressional action to reverse the unfortunate trends present in this and other budgets, that this NASA budget in particular would mark the beginning of an irreversible decline in this nation's development in space and aeronautics."

*Proxmire:* "This is going to be, I think, an interest-

ing hearing. I am delighted that Senator Schmitt has made the kind of statement he has, because it creates the conditions for the sharpest, clearest kind of disagreement. I couldn't disagree more with what the senator has said.

"I greatly respect Senator Schmitt. I serve with him on the Banking Committee. I know how diligent and intelligent he is . . . . At the same time, I strongly feel that we have to hold down spending everywhere, with no exceptions. Everywhere!

"While this program has a great deal of appeal . . . I think we simply have to recognize that much of the space program has a lower priority in terms of its immediacy . . . .

"You can always argue that we should spend more money so that we can develop ways of holding down prices. And sometimes it works.

"But I think that the one kind of action we can take in Congress to get on top of inflation is to be very careful and austere in our spending programs."

*Schmitt:* "Mr. Chairman . . . again, let me emphasize my agreement with the need for an austere budget. But my concern is that as we talk about austere budgets, we remove our capability to ever build deflationary pressures into our economy.

"If we keep deferring those kinds of actions, we are never going to get out of the woods.

"That is probably the basic disagreement that we have—how to both have an austere budget and also build in deflationary pressures for the future.

"I think we have to do both."

*Proxmire:* "Very good."

That was the last time in the hearings that the chairman was to find anything to be "very good." The debate grew increasingly acrimonious as the hearings ground on. Proxmire was to criticize virtually every NASA program in his questions to witnesses, and Schmitt was to counter each of Proxmire's criti-

cisms through his own questions. At times, Proxmire's complaints took on a raving quality.

Proxmire questioned NASA witnesses Robert Frosch and Noel Hinners about lunar sample analysis, one of Proxmire's own pet peeves and a program that he would later move to cut.

*Proxmire:* "I understand there has been very little attempt to synthesize the results of the lunar sample analyses performed thus far and that there have been no good review articles on this work. Is this the case?"

*Hinners:* "I would maintain that it is not the case. One was published about six months ago by Professor Colder of UCLA."

*Schmitt:* "I will provide you with my 1974 review article if you would like."

*Proxmire:* "That is five years old!"

*Frosch:* "I make no particular effort to follow that subject, and I have seen review articles on it."

*Proxmire:* "At any rate, what this criticism boils down to is the fact that a great many individual lunar samples are being analyzed but that there has been very little effort directed to using the results to advance scientific theories of the origin and development of the Moon."

*Frosch:* "I don't know who your informant is."

*Proxmire:* "Let me finish and you will better understand the point I'm trying to make. Apparently, I struck a sensitive nerve." (At this point, there was laughter from members of the audience.) "It has been alleged that we don't even know the average composition of the lunar crust as shown in the samples analyzed thus far. Is this the case?"

*Schmitt:* "Misinformation always strikes a sensitive nerve."

*Proxmire:* "Who is she?" (More laughter.)

*Schmitt:* "That is blatant misinformation."

*Proxmire:* "Go ahead. Tell me what the samples have been able to show us about the lunar crust."

*Schmitt*: "How much time do you have, Mr. Chairman?"

*Proxmire*: "Just give me the percentages of the three major elements."

*Hinners*: "We have more than adequate data that shows what the average composition is, and the variation from the Apollo missions. There is superabundant knowledge on the composition."

*Proxmire*: "We want the averages across the total samples, not variations."

*Hinners*: "You can find anything you want—averages, variations. The global average is a useful number to try to understand how the moon evolves."

*Proxmire*: "Give us for the record the average makeup of the total samples tested thus far."

NASA was later to submit the information for the record.

NASA provides, as a part of its public information program, summer employment for youths in space projects, "career days," "summer institutes," and lecturers and educational materials for schools. When Frosch described those activities, he excited Schmitt, who frequently expresses an interest in the nation's youth, and apparently also struck a sensitive nerve in Sen. Proxmire.

*Schmitt*: "Dr. Frosch, one of the great benefits of the space program to date has been the stimulation that it offers in sometimes very unforeseen ways to young people. I find, more now than ever before, as I go into the school systems of New Mexico and elsewhere in the country, that teachers are using space in some very imaginative ways to teach a wide variety of subjects, not just space . . . ."

*Proxmire*: "Dr. Frosch, if NASA is responsible for what has happened to education in this country over the last 15 or 20 years, you have a lot to answer for. As you know, in every year since 1962 test scores have gone down, not up. It is getting to be a real problem.

"Our children are being distracted by all kinds of things, including programs like 'Battlestar Galactica' and 'Star Wars.' If we are going to bring into the classrooms things that are not as relevant as learning to read and write and add and subtract and do the simple kinds of work that are essential for an educated person, it seems to me we could be in trouble. . . . I think we have to recognize that the fundamental problems in our educational system are not going to be solved by driver education or by getting young people interested in astronomy or something of that kind."

*Frosch*: "I think that what we are doing is giving teachers an opportunity to use the interest and enthusiasm of students for space as a motivation for understanding why they should pay attention to physics and chemistry and arithmetic. That is the way it is cast, not as a 'gee whiz' kind of thing. . . ."

*Proxmire*: "I hope they do their arithmetic to the extent of understanding the costs of the space program. I criticized the notion of having a capsule containing swimming pools, golf courses and a great suburban life rotating between Earth and the Moon. I got all kinds of irate letters from young people saying this is the best way we can spend our money. I wish these kids would learn how to add and subtract and realize there are limits."

"Even though these things are attractive and exciting, we have to have other priorities."

*Schmitt*: "You'd better start listening to the young people, Mr. Chairman."

*Proxmire*: "I listen to them. Sometimes I wish I didn't have to, but I do. They vote at 18 now."

*Frosch*: "I hope they don't get so concerned with adding and subtracting and multiplying and dividing that they forget to have a vision of the future as well."

Proxmire seemed not to have learned how the votes

were stacked on the NASA budget issue until a brief recess for a floor vote just before the NASA budget was to be marked up. His earlier appearance of expecting a lively debate on the issue changed to a demeanor of resignation. Faced with an overwhelming majority of votes against him, Proxmire could only listen ruefully as Mathias recited the terms of his proposal: full restoration of the \$23 million which the House had cut, with certain adjustments to the budget to provide for the initiation of the development of the National Oceanic Satellite System and the Multi-spectral Resources Sampler, both important remote sensing technology programs, and to provide increases in the funding levels of research programs—the Variable Cycle Engine program and Advanced Rotorcraft Technology—and an increase in NASA's energy technology identification and verification effort.

Proxmire tried to get a cut of the \$4 million addition to the Variable Cycle Engine Program, pleading that it must be an attempt to revive the Supersonic Transport. In response to the suggestion, Sen. Schmitt lectured Proxmire on aeronautic technology. He explained that VCE funding increases would provide a larger data base for understanding how advanced technology components can offer better performance with reduced noise and emissions. Further, he explained that the research is necessary if the U.S. is to retain its position in aeronautics technology.

Proxmire was forced to capitulate. Turning to Mathias, he said that he really could not agree at all with the amendment, but, he remarked, "I recognize that you have the power . . . and the glory . . .

"Forever and ever," chimed in Senator Bayh.

Let's hope so.

—The Editors

# **Voices From The Dust**

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**Joan Vinge**





**What really waits  
for us in the Deep?  
Power, Wealth, Glory?  
Certainly.  
But what else?**

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4:30. 4:30 in the morning. 4:30 and fifteen Martian seconds . . . . Petra Greenfeld picked up the wood-grained electric clock and shook it. *Hurry up! Hurry up. . . or else stop.* She set it down on the desk again, too hard in the low gravity, and rubbed her eyes. *To think I've been up all night, and there isn't even a man in my room. I really must be crazy.* She laughed, weakly,

*How can I be crazy and have a sense of the absurd?*

But then why was she sitting here, if she wasn't crazy? Why had she been sitting here all night, like someone condemned, waiting for the dawn? Why wasn't she asleep in her bed like any normal human being—? She swiveled her chair to look at the rumpled sleeping bag on the cot. Because when she slept the pull was stronger, it pried open her dreams and painted the walls of her mind with the red walls of the Valley, and led her, again and again, to an unknown destination . . .

"Oh, *stop* it." She shut her eyes, and turned back to the desk. She wasn't obsessed; she was just upset. Why shouldn't she be upset—that damned Mitradati! Her fist tightened on the graffiti-covered blotter. That egotistical tin god. So he was sending her back to "civilization" today, was he? So her poor, frail little mind needed a rest, did it? Just wait until she got back to Little Earth and made her complaint. They'd let her conduct her investigation without interference, they'd see that her judgments weren't irrational. And that narrow-minded apeman could go suck an egg . . . Better yet, why couldn't she take one of the buggies, and go to the place first? She'd find her proof, she knew where to look exactly where—

She got up from her chair, shaking her head, and began to move restlessly around the small room. Think about something else, anything else . . . *My God, am I really losing my mind? This isn't normal.* Maybe it would be best to get away from here, for a while; from Mitradati, from—the artifact. She hadn't been up to the pole in weeks, hadn't seen a movie, or had a decent dinner, or called Fred. And stuck here with this baker's half-dozen of impossible— No. She couldn't really blame them. Who had been more impossible than she had, these past two weeks?

She looked over at Elke's unused bed, under the

curve where the ceiling became the outer wall. Elke had been sleeping with Sergei lately, and she suspected it was as much from uneasiness about her as it was from passion. At least Elke was sympathetic, and supportive . . . but Elke was a meteorologist, not a geologist, and what did she know? And Sergei, with his damned Russian obsession about parapsychology; making the whole idea sound like something out of a Grade Z science fiction movie. She was glad he had Elke to distract him, before his endless prying curiosity made her do something she would regret.

She saw the cigarettes and lighter Elke had left on the stool by her cot. She picked up the pack mindlessly, took out a cigarette, lit it, inhaled—and, coughing disgustedly, ground it out with her slipper on the cold metal floor. *At least I haven't gone completely insane.* She went back to the desk, looked at the clock again. 4:43. Dawn . . . soon it would be dawn. But why was dawn so important? The hopper wouldn't be going to the north pole until afternoon, on their bi-weekly supply run: this time taking her along in disgrace at Mitradati's order. That was why she was upset, and angry, why she couldn't stop thinking about the artifact—

The artifact: she had seen it lying like a diamond in the rubbly detritus along a canyon wall, twelve days ago, as she and Mitradati had collected rock specimens. And the moment she had seen it, touched it, she had known, she had *known*—It appeared to be a lump of fused ore, unusual, but not extraordinary. Yet somehow she had sensed an unrightness about it, an unnaturalness. And when she had tested it and found an alloy that had never been known to form outside of a laboratory, she had dared to tell the others about her suspicion . . . about her belief: That this piece of metal could never have been produced by natural geologic processes, that it had been made by an intelligent, alien life-form. And furthermore, that its pres-

ence could be a key to an even greater discovery—proof that humanity was not alone.

The reaction had been immediate, and negative. Even she had realized—still realized—that the idea was incredible. But then, this discovery had been incredible! Some of the others, Taro, Shai-lung, hadn't been totally unreasonable; suggesting that it might be a piece of space junk, something from their orbital lab. But Shiraz Mitradatai had rejected the idea coldly, in spite of having no better explanation—calling it, and by implication her judgment, irrational. She had argued with him, pointing out that her past work with an archeological crew had given her a feel for geological samples that were something more . . . that even a conservative estimate claimed observers from another star system would visit this one once in every million years; no time at all, in geologic terms.

She had gone on arguing with him, continuously, while her conviction grew that the most valuable discovery they would ever make on Mars must lie somewhere here in the Mariner Valley. And as her conviction grew that out of the thousands of square kilometers of this tremendous canyon system, she alone could find that proof . . .

Petra wrapped the collar of her bathrobe tightly under her chin. Even though this small temporary base was buried under two meters of insulating soil, the determined Martian cold crept in, and it was always coldest just before the dawn. *And darkest.* Anger drove the chill out of her again as she remembered Mitradatai's contemptuous sarcasm, the hostility lying so clearly below the surface of his 'rational' mind: "Simply because it's 2001, Petra, that doesn't mean an alien monolith is waiting for us." The taunt still stung her . . . No: Haunted her. *Haunted*—She remembered the look on his face, as though he hadn't expected to say the words himself. And she remem-

bered the almost physical pain as the words burst into stars behind her eyes. In that instant certainty had crystalized out of the vague urges moving her forward, and she had *known* what she had to do. As she knew it now . . . .

Petra swore softly and crossed the room to her dresser, pulled open a drawer. The first time she had seen Shiraz Mitradati, among the scientists awaiting departure from L2 for the journey to Mars, she had been strongly attracted to him. But it had been purely a physical attraction, and abruptly short-circuited. Mitradati was an Iranian: although Iran had used its oil money to catch up with the 20th Century (before clean hydrogen fusion had made oil obsolete), she had discovered that social progress—at least as far as Mitradati was concerned—had not kept up with technological progress. He was a believer in Iran's old regime, who would have been much happier in her presence, she suspected, if she'd been wearing a veil.

But once they reached Little Earth on Mars they had gone their separate ways, on separate research projects; up until three months ago, when she had joined this particular geological team, a team that Shiraz Mitradati was nominally in charge of. Neither Elke nor Shai-lung seemed to feel the same irritation with Mitradati that she did, and she had wondered whether it was all her own fault, her own outspokenness, her own opinionation . . . . *Damn it! I'm teaching at Harvard because I happen to have something to say.* It took two to make an argument. Shiraz had refused a perfectly reasonable request to let her investigate her find more fully, and his growing irrational hostility had nothing to do with 'reason' or 'logic'. It was no wonder her own conviction had hardened into an obsession; that even while she was awake the need to go on with her search filled her mind. He had no right to stop her; why should she let

him stand in her way, she didn't have to—

Petra blinked, shivering violently; found herself half-naked, in the act of getting dressed. She stood for a moment staring down at the bulky red sweater clutched between her hands in a death-grip, watched her hands begin to tremble. Then she pulled the sweater roughly on over her head, fastened her pants, and sat down to put on her worn sneakers. She could see the clock on the desk: almost 5:00. A quarter of an hour left until dawn; now was the time, before anyone else was awake. She couldn't afford to have anyone stop her now— She stood at the mirror, folding her straight black hair into a knot at the back of her head, fastening it with a clip; moving methodically now, her face frozen into placidity. Dark eyes stared back at her from the mirror, her own eyes, screaming at her silently, *What are you doing to me?* She shook her head at the caged image, "Oy, Gottenyu, Petra—" She picked up her flashlight and left the room.

She walked silently down the dim hallway, knowing that the room partitions were paper thin. She slipped into the dark stairwell midway along it, switched on her flashlight and went down the steps into the storage area. She needed a vehicle, her pressure suit, and—the other thing she had to find. She moved cautiously among piled crates and equipment, following a thin streamer of light through the dark room, and through the blackness that clotted her brain. This was the right thing, the only rational thing to do . . . *then why am I so afraid?*

The room filled with light, an explosion against her senses. She cried out in surprise and protest, turning—

"Shiraz!" Squinting against the sudden brightness she pulled the figure into focus. She raised her hand with the flashlight to shield her eyes, half-threatening. "What are you doing here?" an accusation.

"I might ask the same of you." She thought there was a trace of sullenness in his accented Oxford English.

"I'm going to prove I'm right. I'm going out to find . . . to find—it." She glanced down, confused, as the image slipped away from her. She looked up again, brandishing the heavy flashlight as he moved. "Don't get in my way, Shiraz! I'll kill you if I have to," knowing, desperately, that she meant every word of it.

"I know you will. I'd do the same, to you, to anybody, now." He moved away from the out-curve of the wall, coming toward her, his hands open and empty. "Petra, listen to me. I'm not here to stop you. I've come for the same reason you have."

"Don't try to humor me, Shiraz. It won't work."

"Humor you! For God's sake! Do I look like I want to be here?" He was close enough now that she could





see his eyes, see the fury and the desperation that mirrored her own. "I don't want to be here! But I couldn't help myself . . . I couldn't stop it. Could you—?" with something in his voice that she had never heard before.

"No." She shook her head, her hand dropped to her side. "I couldn't stop it, either . . . But all this time, you denied it! Why?"

"How could I admit to a thing like that? That I heard 'voices' whispering in my head—like some bloody lunatic. People would have thought I was mad!" She saw his fists tighten, and waited for the outburst. But he only said at last, wearily, "I'm sorry."

She looked down, rubbing her hand across her mouth. "Yes, so am I. We should try not to make this any harder than it is." She realized for the first time that he was already wearing his pressure suit. She turned away, picking a path through the boxes and equipment to the locker, to take out her own suit. She watched her tiny, crumpled image reflecting over and over as she pulled it on. "We'll have to hurry if we want to get out of here before anyone wakes up." She listened to her mind, watching her body obey it unquestioningly—the way a stranger would, the way she watched her reflections move, echoes of her self.

"I know." Shiraz tested his air tanks.

"We have explosives here, don't we? Where are they? We'll need them—"

"It's taken care of. I've already put what we want in the back of the buggy."

"Good." She nodded, checking her own suit. "Do you—do you know why?"

"No. Do you?"

"No." She looked away, down the long half-cylinder of the lower level, toward the air lock. "I don't like being somebody's golem."

She walked slowly along the floor platform, awk-

ward in her insulated suit, to the balloon-tired exploration vehicles parked side by side. "Which one?"

Shiraz followed. "The first one. That's where I put the bomb."

She opened the door and climbed in on the driver's side; he got in on the other, without protest. She wondered whether he was too tense to drive; managed a brief sympathy for the extra strain his inability to accept this nightmarish loss of control must add to the tangle of emotions that already held them both. She leaned past the seat's headrest, glanced into the back of the pressurized cab; saw the drab, unremarkable metal container waiting, and the red radiation trefoil on its side. "Oh, my God . . ." They had set off small, clean atomic blasts to create measurable seismic tremors in their analysis of the planet's core. *But why do we need one now?* She turned back, fastening her safety harness. "Do you know how to detonate one of these? I've never—worked with one."

He shrugged, wiping away sweat. "I've watched it done."

She nodded. She checked the fuel gauge, not sure how far they were going: Full, as usual, a full one liter of water. She started the fusion power unit.

They passed through the lock and up onto the flat, wind-scoured surface of the still-dark canyon floor. The canyon was more like a plain, more immense than any she had ever seen on Earth. Here, where the sub-canyons of Capri Chasm and Gangis Chasm intersected, the floor of the Mariner Valley was nearly two hundred kilometers wide; wide enough that the distant two-kilometer wall bounding this trisection of the floor seemed more like a line of distant mountains dancing at a desert's edge. She turned almost due west, toward the mouth of Gangis Chasm, knowing as she had known for so long, with such aching

certainty, that this was where her destiny lay.

"*Kismet*," Shiraz said absently, not even looking at her.

"Kind of florid; isn't it?" She managed a smile.

He managed laughter. "Perhaps there is a monolith waiting for us, after all."

The headlight spilled out like bright fluid, highlighting the stone-studded ground. The dim brown of the undifferentiated surface still in darkness stretched to the far canyon wall, which became a gleaming band of gold as the sun rose behind them. Petra glanced at the side mirror; seeing the unnatural cylindrical hummock of their buried lab silhouetted with the low, conical hills that lay scattered like a case of hives over the flatness. She looked out again at the slowly brightening plain, and at Shiraz's dark, tense profile at the corner of her sight. She had meditated often enough on the symbolism of his name, finding it more than fitting in her aggravation—Mitradatai, from Mithra, the mace-wielding Persian god of war, the paternalistic Protector of his People . . . . Now suddenly she remembered another of Mithra's aspects: god of the light that precedes the dawn. She let her mind probe the possibilities, searching for one that might be a symbol of hope.

The jouncing vibration of their progress increased uncomfortably; she eased her foot on the accelerator. In Mars' lighter gravity every bounce and swerve was accentuated, but the jarring that followed it was gentler than on Earth. She remembered her first painful ride, years before, in a dune buggy: the grotesque, frivolous Earthside hybrid that had become so indispensable to her work in the desert, and to the exploration of Mars . . . remembering the stark fantasy of the desert, and the tennis-ball sized bruises the seat-belt had left on her hip-bones. She felt suddenly, unbearably homesick.

*Why me? . . . why us?* Why were they doing this; why



couldn't they at least understand . . . . *Because it doesn't have to let us understand anything.* She tried to focus her resentment against the straitjacket bonds that held her free will prisoner. Even terror, even fear—anything to give her strength. But emotion dissipated the way the paper-thin film of frost sublimed as the ground warmed. It was useless, it was pointless.

The day opened onto the full rust-red brilliance of the endless Martian desert. The dusty sky was salmon pink now around the horizon, deepening rapidly to a black-red zenith. The cloud of fine dust lifting behind them became an auburn haze against the sunlight. She turned southward, slightly, to take them through the gap of flat desert pavement between a tremendous black-sand dunefield to her left, and the kilometers-long slope of slumped earth and talus that fanned from the canyon's north rim on her right. Above the jumbled slope she could see the pit in the profile of the sheer canyon wall, where the rim of a shallow crater had fallen away with the collapsing cliff-face.

She could picture the canyon and the cratered plains that lay above it as they looked from the air. She had seen them coming here from the polar base, from the southeastward descending arc of the shuttle's trajectory from pole to equator. She pictured the chain of magnificent volcanoes that were the Tharsis Mountains lying beyond the far end of the Valley, four thousand kilometers to the west—those mountains that dwarfed any on Earth, as the great rift valley itself almost defied her attempts to comprehend its scale. She had been deeply moved by the wonders of this alien world, where geology existed on such a grand scale: loved its strangeness and its familiarity, with the breadth of emotion that belonged to all who loved the faces and forces of the natural world, and the depth of emotion that belonged to those who truly

understand them. *And never more than now: Where am I going? Will I ever see them again?*

Or ever see Earth again . . . The limonite-stained cliffs were much closer on their left, now; the red, convoluted walls reminded her of the Near East, her journey to Petra, the City in the Rock—her namesake. She saw in her mind the ancient city, hidden in a cleft of red sandstone, its temples and dwellings built from and into the rock itself: a timeless thing, a part of the earth . . . And the sun-bleached mudbrick villages that had not changed in a thousand years, or two, or three; that lay drowsing on parched hillsides an hour's drive from some twenty-first century metropolis. An hour's drive, in an air-conditioned time machine . . . She had spent three years in Israel, as the geologist for a Harvard-sponsored archeological crew, and they had been in Tel Aviv during Israel's Fiftieth Anniversary celebrations, laughing, drinking, dancing, embracing and being embraced by joyful total strangers.

Yesterday and today . . . and tomorrow: She was here on Mars, now, as a part of this project that celebrated the turning of a new millenium. Enough honor for a lifetime . . . *But I'm not ready for it to end! Will there really be a tomorrow? And what kind will it be—none that I ever imagined . . .* She saw suddenly in her mind the smiling, freckled face of Fred Haswell, astronomer; who had been so much a part of this place, become so much more than just a friend to her, before his stay here had ended four months ago. Now, not knowing whether she would ever see him again, or touch him, or feel a man . . . *Oh, Lord; this is no time to get horny!* She bit her lip.

"A penny for your thoughts?" Mitradatai said.

She looked away instead of at him; at the menhirs of dark volcanic stone that crouched like confused giants along their path, casting long shadow-fingers across the black sand. There were red anti-shadows

stretched in opposition, where the ground was free of sand in the wind's lee. "I . . . I was watching my whole life pass before my eyes, I think." She felt herself begin to blush, and kept her face turned away.

"Isn't that what you're supposed to do before you die?" Softly.

"I guess so. But I hope not." Her gloved hands tightened on the wheel. "There— isn't much else to think about. Or to say. Is there?" She looked back at him, at last.

"No." He shook his head, leaned back against the headrest, his own hands closing over his elbows. "Turn up the heater, will you? I'm feeling rather cold."

She turned up the heater. Up ahead, beyond the field of black sand, she could see another, smaller avalanche of dirt and rock spilling down from the opposite wall of the canyon. She looked back at him as his gaze left her. *Mind control makes strange bedfellows*. She sighed, studying his profile again, his close-cut, curly hair, the bushy, drooping moustache that had so fascinated her the first time she saw him. She smiled unhappily, looking away again, paying attention once more to their progress up the canyon. Her interests and his were similar; their heritage, reaching back over thousands of years, was similar. But their personalities were still poles apart. Or were they too much alike—?

"Have you ever been to see Persepolis?"

"No." She shook her head, loosened her stiffening neck muscles. "I wish I'd had the chance to . . ." She went on, determinedly, "I will see it, the next time I work in the Near East. I want to climb those magnificent stairs."

"And see those columns standing like sentinels above the past, against a *blue* sky—" He stared out at the glaring red-black dome above them. Petra saw a handful of tiny clouds, very high up, their whiteness

tinted faintly pink by the haze of dust. "Did you know that some of the beliefs in the Old Testament were influenced by the teachings of Zoroaster?"

She smiled, nodding. "The name of the Pharisees probably came from the word for 'Persian'."

"How far do you think we're going?"

"I don't know either."

"If you get tired of driving, let me know, and I'll change with you."

"All right. Thanks." She realized, with a selfish possessiveness, that she was grateful to have even the driving to help keep her mind occupied.

They reached the end of the gigantic slope of fallen cliff-face at last, and she angled their track across the canyon floor again, closing with the northern wall. She watched the wall come at them, inexorably, rising and rising, a rippling tidal wave of stone; she imagined herself drowning. Hours had passed already, and continued to pass. The sun rose to its zenith behind them and began to drop forward, getting into her eyes, as she followed their unchosen course along the foot of the canyon wall. They had brought no food with them, but she was not hungry or thirsty, not even tired. Mitradati said little and she said less; her self-awareness ebbed. She felt herself slipping further into a kind of fatalistic boredom, her thoughts almost formless, meaningless.

She could not remember anything she had been thinking, when at last she was able to realize it. They were passing the point of a protruding arm of the red-stained cliff; she began to see another of the endless side canyons that crennelated the heights. But a sudden emotion, utterly unexpected, filled her as the new subcanyon emerged before them: Anticipation? Excitement? Recognition . . . . Inexplicable knowledge that they were reaching the journey's end at last.

Shiraz stirred in his seat, leaning forward, peering



out with what looked like eagerness. "We're almost there!"

"Yes—" And the alien emotion, or lack of emotion, within her became recognizable longing again. The shapeless fears that had dulled her desire to reach this goal fell away and were forgotten. This canyon was broader and deeper than most; she studied it for a way up into its network of dry channels and tumbled rock. The canyon became a sheer cleft about a kilometer above them, above an outcropping of resistant strata; but below that point the wall had been undercut, when water, and later windblown sand, had eaten away the weaker rock beneath it to form a natural shelter. Her eyes lingered on that hollow in the rock, a memory of the cliff-dwellings of the American Southwest moving across it like a cloud shadow. She could see nothing up there, yet . . . And yet she was certain now that something was there, something more important than anything a human being had ever discovered—

"Can't you get up there any faster?" Shiraz's voice was sharp with frustration.

She got them up there, as fast as she could, over terrain and past obstacles that she would never have dared if she had had any freedom to make a judgment. She stopped the buggy at last, twenty meters below the final ledge that was their destination. "I can't get us any closer than this. We'll have to climb from here."

"All right."

Shiraz picked his helmet up from the floor, and she picked up her own, catching it on the steering wheel in her haste. She settled it on, barely latching it in place in time before they were unsealing the doors and leaping down into the thick, talc-fine, cloying dust. The red-stained dust was darker and duller where it had been disturbed, making her think of midden soil. Making her realize that they were about

to unearth a greater mystery, and gaze on the future/past . . . . She saw Shiraz haul the drab, rectangular container that was the bomb out of the back seat, and felt dark doubt gnaw at the edges of her desire. "Do you think anyone will come after us? Maybe they're already searching—they must wonder where we've gone." She realized for the first time that she had never switched on the radio, never even thought to try. An unfamiliar heaviness clogged her chest.

"Probably. They know something is wrong by now. But we must have a big lead on them, whatever they decide to do. It won't make any difference." Doubt clouded his own face again.

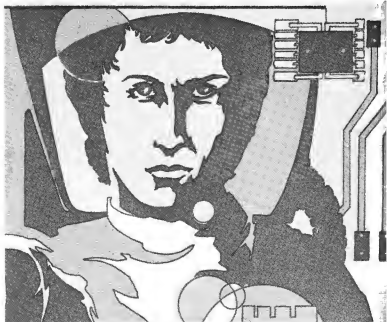
They struggled up the final slope, pushing and lifting and dragging the metal box and each other; until they stood finally on the wide ledge below the overhang of ancient basalt. Petra turned slowly, breathing hard, her heart pounding with exertion and excitement.

The compulsion that had drawn them here by an invisible thread intensified stunningly inside her; as though she had passed through a doorway, letting the psychic pull she had known only as a deep, formless vibration burst over her, reverberate through her. She was dimly aware of a human sound, a grunt of astonishment, had no idea whether it had come from Shiraz's throat or her own. She was frozen in the moment, utterly absorbed in the awareness of what was happening to her, a thing that no human being had ever experienced before: the communication of an alien mind. The presence grew and grew inside her own mind, taking form, focusing. She strained toward it with all her will, straining to understand—

And suddenly she did understand, as the swollen presence clogged her brain and paralyzed her synapses: a cold, unfeeling radiation, without meaning, without—life. Like a machine . . . a machine programmed to lie in wait for centuries; but not in

order to share with humankind the secrets of an interstellar society. There was no intelligence here, there would be no answer, no revelation, just—

A pile of ruins. Across the plateau, a jumble of red native stone, a warren of broken circles and irregularities filled with rubble, reaching back and back into the russet shadows below the overhang. A ruin. A cypher, empty of meaning, long since empty of life. Still she did not *know*—and she realized that she would never know; never feel illumination break the heavy clouds of compulsion . . . The Unknown held her in bondage, and she meant less than nothing to it. The emotion that swelled in her, straining at her bonds, was not alien any longer—it was not even fear, but anger. Her eyes burned with fierce disappointment, and fiercer determination: She *would* know, she would find out! She moved forward, unexpectedly free to move, taking easy, unresisted bounds



across the level surface. Shiraz called after her and she felt him follow. She reached the ruins ahead of him, found that they were even more immense than she had realized. The broken walls were twice her height, wearing deep skirts of dust, and they stretched away for hundreds of meters. She ran her gloved hands over the dust-filmed wall, along the line that age was etching between perfectly-matched precision-cut surfaces of stone. The ruining of this place had taken a long time. She was suddenly, totally certain that it was an ancient thing; that it had been waiting, waiting for millennia. But not for her . . .

Shiraz stopped beside her, bent over to set the bomb container down against the wall. When he straightened again she saw the despair on his face. And she knew then, just as certainly, that this was all they would ever know, all that they had ever been meant to understand . . . They had not been chosen receivers of an alien secret to be shared with all of humanity; they were the chosen destroyers, because humanity had never been intended to know of this. "We're going to blow it up." Not a question. "Nothing will be left." And the mindless presence within her reveled at her understanding—at its own victory, and their defeat—without any comprehension of the significance of the act.

He nodded wordlessly, prying the lid loose on the box. He lifted out a small remote control unit and set it aside; the detonator, she supposed. She watched him begin to flick a switch, twist a knob, inside the box.

"Is the process very complicated?"

He shrugged, flicking another switch. "A bit. Not terribly."

"Is there any chance of making a mistake—?"

He looked up at her, bitterly. "Not intentionally." He looked down again, a stiff, resisted movement. "I

have to concentrate . . . ."

She turned to gaze out over the rim of the ledge, down the valley, seeing the sunwashed canyon floor beyond like the ruddy golden fields of heaven. Searching for movement, fruitlessly.

"All right." He stood up finally, dust coating his knees. The detonator was in his hand. "Let's get out of here."

They began to walk back toward the sunlit rim of the ledge, toward the buggy waiting below, toward safety. And every step became slower, more leaden, more difficult . . . more impossible. "Shiraz?" Her panic leaped with the terror she heard in her own voice. She stood straining like an animal at the end of a leash.

"Petra . . . I can't go any further. I can't—" She saw his empty hand reaching as his body jerked around to face her. Five meters beyond him lay the path down to the buggy, and escape.

But they would not be allowed to use it. "No witnesses?" she said softly, meeting his eyes.

"No . . ." He looked down at the detonator in his hand. She watched him try to throw it away, and fail.

She swallowed, wetting her dry throat. "Oh, God. I wonder if our medical plan covers blowing yourself up while mind-controlled?"

"Allah! Can't you do anything but make jokes—"

She laughed uncertainly. "I've either got to laugh or cry, and if I have to die I'd rather die laughing."

He made a noise that was either amused or disgusted. "What are the rules of this game? I wonder if we're allowed to lie down flat?"

"Try." She fought her trembling body with one last, frantic calling-up of outrage and fear; felt her knees give way, dropping her painfully onto the rocks. But her spine was a steel rod and she knelt, paralyzed, watching Shiraz struggle to do the same. "It's a good position for prayer, at least . . ."

*Help me, God, help me—*

She was sure it was a laugh, this time. "Where's Earth; I've lost track of Mecca."

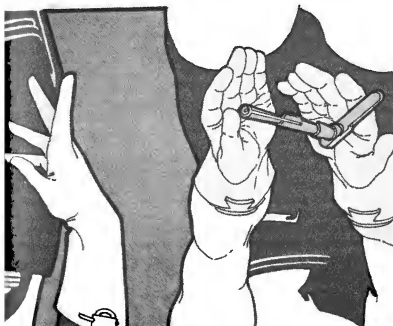
"You can't see it from here." She twisted, trying for one more glimpse down the canyon. "If you had a last wish, what would it be?"

"That I was somewhere else."

"Scared?" Her own voice broke.

"Shitless." He raised his hands unsteadily, holding the detonator out like an offering, kneeling in this alien temple where they were about to become a human sacrifice . . . He murmured something in a language she didn't understand. And he pressed the button.

She kept her eyes open, staring in agonized disbelief: As a blinding ball of orange light blotted out the silver dome, a cloud of smoke and rubble rose to blot out the fire, a fist of smoke and shock and sound swept toward them through a split-second's eternity—



struck her with sickening force, throwing her back and over the rim of the ledge like a rag toy.

Awake, aware, she found herself lying dazed on the slope. Still alive. She felt her body with her mind: sprawling twisted on its side, head down, faceplate down in the red dust. Stones and pebbles still pelted her. She thought she heard, dimly, the *bang* of a stone on metal; tried to raise her head, gasped as pain like an electric shock stabbed at the base of her neck. But before her head dropped forward again she saw the buggy, barely three meters below her, and the still body wedged against it . . . .

"Shiraz?" She lay face down again, putting all her strength into the one word. "Shiraz—?" No answer. Grimly she drew a leg in, pushed off; crawled and slid on her stomach down the slope, whimpering and cursing. She reached his side, saw his face through his helmet glass, saw blood on it. And his eyes shut, no response. She couldn't tell whether his bulky, insulated suit was still pressurized, whether he was even still alive. But one leg lay crumpled beneath him, like a twisted branch, like nothing that belonged to a human being. She almost shut her eyes; didn't, as she focused on the faintest whisper of whiteness in the air above it. A tiny, fragile cloud of condensing moisture . . . the suit had torn. She fell back, bright fire exploding in her head as she struggled to release the catch on the equipment belt at her waist. She pulled it loose, forced it under his suited leg above the tear, not even aware that she was sobbing now. She drew it tight and jammed the catch, barely able to see her hands through golden fog, the rushing water of noise that drowned her senses. *The radio.* If she could only get to the radio. She tried to push herself up, to reach the door handle. But the one meter to the door handle might as well have been the distance to the sun. She collapsed helplessly across his legs, her strength

gone.

But she knew, with ironic grief, before her senses left her too, that she was free to use it if she could. That her mind was free of the compulsion at last, that at least she would be free forever when she died . . .

"Hello, Shiraz." Petra entered the quiet, dim-lit room where Shiraz Mitradatai lay, sat down in the chair at his bedside with exquisite care. "Dr. Leidu told me you felt like talking. I'm glad. So do I." She drew the collar of her robe closer around the thick, white neck brace. "There's not really anyone else who understands . . ."

"I know." He smiled at her from the pillows, his face hollow and tired. "Thanks for coming. It's good to see you—up and around already."

"All it took was a little chicken soup. It works miracles. You should try it." Her mouth twitched, still not quite ready for laughter. Her head hurt, as it had hurt for the past four days, relentlessly. "It will be good to see you up and around again, too."

"Not for a bit, I'm afraid."

She glanced down, uncomfortably.

"But I'd never be up again at all if you hadn't stopped that leak in my suit. I want you to know how grateful I am for that."

She looked up again, smiling, embarrassed. "I never believed they'd ever find us, anyway; not in time. But they saw the dust cloud from the explosion. The thing that almost killed us saved us, in the end."

"But why didn't it kill us in the first place? We had no right to survive; it was impossible, we should have been incinerated—"

"Didn't they tell you?" She turned her head too quickly, felt the drug-dulled ache flare up, making her wince.

"Tell me what? . . . I haven't been in the mood for much conversation since I woke up." His hand moved



along the cold metal rail at the edge of the bed, tightened.

"That you made a mistake." Her smile felt real, and warm, and right to her; this time. "You never disengaged the fail-safe on the bomb; only the core explosive went off, there was no atomic blast. That's the only reason we're still in—still here to talk about it."

"Well." Faint humor brightened his eyes. "No one's perfect, after all—not even me. What about the ruin?"

"Partly buried. Part of the overhang came down on it. A team is there excavating already."

"Has anyone else had any—trouble, working with it?"

"No. No more trouble." She settled back in the plastic chair, trying to find the position that hurt the least.

"Can anyone explain what happened to us? How some—alien *thing* we never even saw could turn us into time bombs?" His voice grew more agitated.

"They found the thing that did it." She felt him look at her abruptly. "Just a machine." *Just a thing.* "Nothing more than a twisted-up mess of ceramic and metal. There was still a little 'life' in it; enough to pick up on instruments once our people started searching the rubble for it . . . ." She saw him tense. "But the blast broke its back." Her hands felt her neck brace unconsciously. "I knew that, I felt it, even before we were rescued—that we were finally free."

"How—how does it work?"

She tried to shrug. "They have no idea . . . yet." She wondered suddenly what would happen to humanity if they ever found out. "But I told them everything I remembered. Enright figures the thing must have been left there on purpose, like—like a mouse-trap, for any sentient creatures that might pose a threat. He says it must set up a feedback in the mind; in a way, you yourself provide your own mind-

control. What appeals to you draws you, and helps tune out your willpower."

"But why? Why would someone leave something like that in a ruin? And—why *us*? Why were we the victims?" He pushed himself up from the pillows, hurling his anger against an unreachable persecution, an unrightable wrong.

"We found the bait, the piece of cheese—that artifact." It seemed to her as though it had happened a lifetime ago. She wondered how many other treacherous clues were scattered through the Mariner Valley; harmlessly, now. "Maybe we were the most curious; I don't know." Lines tightened between her eyes. "Just lucky, I guess." Trying to keep it light, she heard her own unhealed fear betray her. "But why the ruin was left boobytrapped . . . . Do you remember what it—what it felt like, that *thing*," her own voice attacked it, "when it got into our minds?"

He nodded, tight-lipped. "Ruthless. Arrogant. Megalomaniacal . . . as though the ones who set it up would have enjoyed making us grovel, watching us destroy ourselves."

She wrapped the tie of her bathrobe around her fingers. "Yes . . . . Ironical, isn't it, that after all its arrogance we were too dumb to destroy ourselves. But a—feel like that belongs to an invading army, a military outpost; assuming they were anything like us . . . ."

"Are anything like us."

"Were." She moved her head cautiously from side to side. "Those ruins have been there for three millennia, at least. Maybe they were boobytrapped because the Martian Foreign Legion was being forced to retreat. The way the place was built of native stone—and it extends underground, too; as if it was designed to stay hidden. Maybe they expected a visit from the Other Side."

"Or from us. They wouldn't have bothered to be so subtle with an active aggressor, I'm sure."

"Maybe not. No one else ever found it, or came back to reclaim it, anyway."

His head fell back against the pillow, he stared at the ceiling. "I was just thinking . . ."

"What?"

"About 'flying saucers' . . . and Ezekiel's 'wheels in the air'. Good Lord. What kept them from tampering with Humanity, I wonder?"

"Maybe they did."

He grimaced.

She smiled faintly. "And a lousy mess they made of it, if so."

"But that's all meaningless, now, anyway. The only real proof we have of other life in our system—or in the galaxy—is here on Mars: these ruins, left by some ruthless monsters who have been dead for thousands of years. A relic, a curiosity, a problem for the academics." His hands bunched the blankets. "It isn't worth it! It isn't worth dying for. It isn't even worth . . . having survived." He looked down along the bed at his hidden body. "They told you, about my—about my leg?"

She followed his pointing hand unwillingly, saw the terrible lack of symmetry that she had tried not to see beneath the blankets. His broken leg had been injured too badly; without the sophisticated medical care available on Earth, they had not been able to save it. Dizzy, she said evenly, "Yes, they told me. I'm very sorry." She met his gaze until he looked away. "But it was worth it, Shiraz." A part of her own mind shouted that she lied, that the price he had paid—they both had paid—in suffering and terror was too high. For the sake of his sanity and her own, she let her voice drown it out: "We won, even by default. We're alive, we have their artifacts to study, we'll learn their secrets!" *What secrets, from an abandoned*

*outpost? Cooking pots and dirty underwear?* "We are going to learn what it was all about, after all. Our monolith, our alien treasure . . . God, I can't wait to get at it! Proof that other intelligent beings exist in the universe. It really is a treasure of knowledge—" finding to her surprise that she was genuinely beginning to feel the enthusiasm she forced into her voice. She saw a spark of belief begin to catch in the cold emptiness of Shiraz's eyes; reached out to him, stretching forward. "Oh!" She sank back, raised her hands to her head, dazzled by pain-stars. "Such a headache I never had in my life; like a dozen hangovers piled on top of each other." She lowered her hands to the neck brace, swallowing her pain, because his trace of a smile had disappeared. "And how do you like my horse collar? I feel like I should be pulling a plow."

"At least it's something you'll be able to get rid of. I expect you'll be able to get back to your work quite soon. I wish I could be as lucky. That's the only real regret I have—that the rest of my stay here will be wasted. I won't be able to finish my work . . ."

"*Dreck,*" she said sharply. "I don't see why not. It's not your mind that you've lost." He looked back at her, frowning. She put out her hand, carefully this time, and touched his arm. "You'll get around perfectly well with a cane in one-third gee. And with a prosthesis, back on Earth, you'll be better than new. Wait and see . . . you'll want to get back to work. This is *our* discovery, yours and mine. You won't be able to stay away—not from the discovery of a lifetime. I know you; and believe me, you're much to vain for that, Shiraz."

"Am I?" The frown eased into an uncertain bemusement; he lay back. "I know, thousands of other people have had to live with it. I suppose I shall go on living too; like it or not . . . Maybe a missing leg will give me a certain exotic mystery, like an eye

patch; and make me more attractive to the ladies—"

She saw suddenly that he had lied when he said that he had only one regret. "Especially when you tell them that story about being kidnapped by aliens. Aliens who haven't been here for thousands of years."

"Maybe it might even make me more attractive to you." He held her eyes, with an expression she couldn't read.

She blinked, silent with surprise.

"Maybe when we're both back on Earth, when you come to see Persepolis, you'd go to dinner with me?"

"Why do we need to put it off for years?" She let a smile form slowly, hesitantly; was glad, when she saw his smile answer it at last. "Afterwards, we could go up to my place, sip a little wine, watch our own private Late Show . . . I could even check out *2001* at the tape library—"

For a moment, they stopped smiling again.

—Joan D. Vinge

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**FORWARD**

**THE  
NEW  
WORLDS  
OF**

**ROBERT A.  
HEINLEIN**

**EXPANDED UNIVERSE**



## COMING NEXT ISSUE: MASSIVE EXCERPTS!

**Warning!** Truth in advertising requires me to tell you that this volume contains THE WORLDS OF ROBERT A. HEINLEIN, published 1966. But this new volume is about three times as long. It contains fiction stories that have never before appeared in book form, nonfiction articles not available elsewhere, a 30-year updating on my 1950 prognostications (as well as the 15-year updating that appeared in THE WORLDS OF R.A.H.), with the usual weasel-worded excuses as to why I guessed wrong—and (ruffles & flourishes) not one but *two* scenarios for the year 2000, one for people who like happy endings and another for people who can take bad news without a quiver—as long as it happens to somebody else.

On these I will do a really free-swinging job as the probability (by a formula I just now derived) that either I or this soi-disant civilization will be extinct by 2000 A.D. approaches 99.92+ %. This makes it unlikely that I will again have to explain my mistakes.

But do not assume that *I* will be the one extinct. My great-great-great-grandfather Lawrence Heinlein died prematurely at the age of ninety-seven, through having carelessly left his cabin one winter morning without his gun—and found a buck deer on the ice of

his pond. Lack of his gun did not stop my triple-great-grandfather; this skiful of meat must *not* be allowed to escape. He went out on the ice and bulldogged the buck, quite successfully.

But in throwing the deer my ancestor slipped on the ice, went down, and a point of the buck's rack stabbed between his ribs and pierced his heart.

No doubt it taught him a lesson—it certainly taught *me* one. So far I've beaten the odds three times: continued to live when the official prognosis called for something less active. So I intend to be careful—not chopped down in my prime the way my ancestor was. I shan't bulldog any buck deer, or cross against the lights, or reach barehanded into dark places favored by black widow spiders, or—most especially!—leave my quarters without being adequately armed.

Perhaps the warmest pleasure in life is the knowledge that one has no enemies. The easiest way to achieve this is by outliving them. No action is necessary; time wounds all heels.

In this peaceful crusade I have been surprisingly successful; most of those rascals are dead . . . and three of the survivors are in very poor health. The curve seems to indicate that by late 1984 I won't have an enemy anywhere in the world.

Of course someone else may appoint himself my enemy (all my enemies are self-appointed) but I would not expect such an unlikely event to affect the curve much. There appears to be some unnamed ESP force at work here; the record shows that it is not healthy to hate me.

*I* don't have anything to do with this. The character can be more than a thousand miles away, with me doing my utter best to follow Sergeant Dogberry's advice; nevertheless it happens: He starts losing weight, suffering from insomnia and from nightmares, headaches, stomach trouble, and, after a bit, he starts hearing voices.

The terminal stages vary greatly. Anyhow, they are

unpleasant and I should not be writing about such things as I am supposed to be writing a blurb that will persuade you to buy this book despite the fact that nearly a third of it is copy you may have seen before.

Aside from this foreword the items in this book are arranged in the order in which written, each with a comment as to how and why it was written (money, usually, but also— Well, money)—then a bridging comment telling what I was writing or doing between that item and the next.

The span is forty years. But these are not my memoirs of those four decades. The writing business is not such as to evoke amusing memoirs (yes, I do mean you and you and you and especially *you*). A writer spends his professional time in solitary confinement, refusing to accept telephone calls and declining to see visitors, surrounded by a dreary forest of reference books and somewhat-organized papers. The high point of his day is the breathless excitement of waiting for the postman. (The low point is usually immediately thereafter.)

How can one write entertaining memoirs about such an occupation? Answer: By writing about what this scrivener did when *not* writing, or by resorting to fiction, or both. Usually both.

I could write entertaining memoirs about things I did when not writing. I shan't do so because a) I hope those incidents have been forgotten, or b) I hope that any not forgotten are covered by the statute of limitations.

Meanwhile I hope you enjoy this. The fiction is plainly marked fiction; the nonfiction is as truthful as I can make it—and here and there, tucked into space that would otherwise be blank are anecdotes and trivia ranging from edifying to outrageous.

Each copy is guaranteed—or double your money back—to be printed on genuine paper of enough pages to hold the covers apart.

—R.A.H.



